NATIONAL RESOURCES BOARD

REPORT . . . DECEMBER 1, 1934

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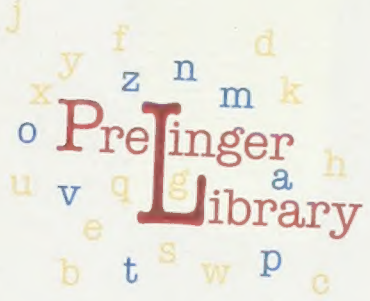

San Francisco, California
2008

NATIONAL RESOURCES BOARD

A Report on National Planning and Public Works
in Relation to Natural Resources and Including
Land Use and Water Resources
with
Findings and Recommendations

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DECEMBER 1, 1934

Submitted to the President in Accordance with
Executive Order No. 6777, June 30, 1934

UNITED STATES GOVERNMENT PRINTING OFFICE WASHINGTON : 1934

National Resources Board

Interior Building

Washington

November 28, 1934.

The President,
The White House,
Washington, D. C.

My Dear Mr. President:

We have the honor to transmit herewith the report of the National Resources Board with the supporting documents used in its preparation.

This report carries this significance: That it is the first attempt in our national history to make an inventory of our national assets and of the problems related thereto. Moreover, for the first time it draws together the foresight of the various planning agencies of the Federal Government and suggests a method for future cooperation.

The members of the Board have not all had an opportunity to give full consideration to all of the points involved. However, they unanimously agree in principle and desire to indicate to you their belief in the great importance of this study and of initiating steps toward the accomplishment of the broad program therein outlined.

Very respectfully yours,

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Secretary of War

Henry A. Wallace
Secretary of Agriculture

Daniel C. Roper
Secretary of Commerce

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FOREWORD

The natural resources of America are the heritage of the whole Nation and should be conserved and utilized for the benefit of all of our people. Our national democracy is built upon the principle that the gains of our civilization are essentially mass gains and should be administered for the benefit of the many rather than the few; our priceless resources of soil, water, minerals are for the service of the American people, for the promotion of the welfare and well-being of all citizens. The present study of our natural resources is carried through in this spirit and with a desire to make this principle a living fact in America.

Unfortunately this principle has not always been followed even when declared; on the contrary, there has been tragic waste and loss of resources and human labor, and widespread spoliation and misuse of the natural wealth of the many by the few.

The conservation movement begun a quarter of a century ago marked the beginning of an organized national effort to protect and develop these assets; and this national policy was aided in many instances by the individual States. To some extent the shameful waste of timber, oil, soil, and minerals has been halted, although with terrible exceptions where ignorance, inattention, or greed has devastated our heritage almost beyond belief.

This report of the President's National Resources Board brings together, for the first time in our history, exhaustive studies by highly competent inquirers of land use, water use, minerals, and related public works in their relation to each other and to national planning. The report lays the basis of a comprehensive long-range national policy for the conservation and development of our fabulous natural resources. If the recommendations contained herein are put into effect, it is believed that they will end the untold waste of our national domain now, and will measurably enrich and enlarge these national treasures as time goes on.

An examination of the reports upon land, water, minerals, and public works, respectively, shows the importance of considering these special factors in their relations to one another, and to economic and governmental problems as well. Water policies and land policies cannot be planned except as taken together, and evidently minerals cannot be considered apart from land in a planning program. Erosion is a problem of land and water; afforestation is likewise a problem of land and water; flood control is related to navigation and also to land cultivation systems. Water pollution is closely related to industrial development, as well as to sanitation, urban and rural. Reclamation policies are inseparable from the agricultural policy of the Nation, while the recreation policies discussed in relation to land and water are appropriate to any comprehensive plan for social welfare.

It is the special purpose of the National Resources Board to bring together these and other social interests, sets of data, and principles of action, and to consider them from the over-all position of national policy. In so doing, we should guard against too narrow a view of the possibilities of natural resources development, attractive as they are. The economic crisis in the United States was not caused by erosion, serious as its inroads are on our soil assets; nor is unemployment due chiefly to lack of adequate flood control, calamitous as the consequences of floods are in many instances. It is too much to suppose that the proper development of our drainage basins will of itself solve the problems of the perplexed body politic.

The problems centering around land and water cannot be solved in these terms alone, but require for their practical and successful treatment a full consideration of the broader but closely related aspects of agriculture, industry, labor, transportation and communication, health, education, public finance, governmental organization.

Finally, human resources and human values are more significant than the land, water, and minerals on which men are dependent. The application of engineering and technological knowledge to the reorganization of the natural resources of the Nation is not an end in itself, but is to be conceived as a means of progressively decreasing the burdens imposed upon labor, raising the standard of living, and enhancing the well-being of the masses of the people. It follows that the social directives back of such technical programs should be developed by persons competent by training and point of view to appraise the human values involved.

A *continuous national planning* agency was recommended by the National Planning Board of the Public Works Administration in its report last June. By Executive order, on June 30, 1934, the President established the National Resources Board as successor to the National Planning Board and the Committee on National Land Problems, consisting of the Secretary of the Interior, Secretary of Agriculture and the Admin-

istrator of Federal Emergency Relief. Thus the new Board represented a consolidation of previously existing agencies and a continuation of earlier activities.

As its first task, the National Resources Board was directed to prepare a report on land and water resources to be presented to the President by December 1, 1934. In this emergency undertaking the Board had the aid of two technical committees, one upon land planning, the other upon water planning. It is significant that, after careful study of the special problems assigned to them, both of these committees presented reports reiterating the need of a permanent planning organization.

State and regional planning has been assisted by the National Resources Board through continuation of assignment of consultants to State planning agencies. Largely as a result of the suggestions and stimulation supplied by the National Planning Board and the Federal Emergency Relief Administration, 42 State planning boards have been set up by the governors of the respective States and are actively functioning today.

Public works planning was studied intensively by the National Planning Board and a series of researches was arranged and carried to completion. From these data, long-range policies have been developed and are now available for consideration in connection with legislation for the continuation of the Public Works Administration.

Water planning was given a new importance and broader interpretation through the work of the Mississippi Valley Committee of the Public Works Administration and the President's Committee on Water Flow. Since a large proportion of the construction bill of the Federal Government is paid out for projects related to water—power, dams, navigation improvements, flood control, etc.—it is particularly appropriate that a water program should be prepared at this time as a sample of public-works planning. For this work, the former Mississippi Valley Committee has become the water planning committee of the National Resources Board.

Land planning studies have similarly been carried on continuously over many years, but new efforts were beginning to bear fruit in the Committee on National Land Problems and the Agricultural Adjustment Administration when the National Resources Board was organized. Through the land planning committee, previously set up by the National Planning Board, this work has been coordinated and a restatement of new and old policies is now submitted.

Mineral planning studies were begun by the planning committee for mineral policy upon its appointment by the President last April and have been continued with assistance from the National Resources Board. The preliminary findings of the committee are summarized in the following pages.

These matters are treated in this report in accordance with the following table of contents.

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PART I
REPORT OF THE NATIONAL RESOURCES BOARD

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FINDINGS AND RECOMMENDATIONS

The program indicated in the following sections may be expected, if carried through, to

1. Provide for the systematic development of our water resources for purposes of sanitation, power, industrial uses, transportation, recreation, domestic consumption, and other collateral uses on a far higher level than ever before.

2. Remove the recurring menace of great floods and vast losses to persons and property.

3. Reduce the heavy losses of soil caused by uncontrolled erosion.

4. Eliminate the use of land incapable of affording a minimum standard of living, develop agricultural production on the most suitable soils only, and aid in raising the standards of living in many agricultural regions.

5. End the wasteful use of our mineral resources and substitute a national policy of mineral conservation.

6. Make available large areas of land for purposes of popular recreation.

7. Assemble basic data in regard to mapping, public finance, and population, necessary for national planning.

8. Avoid the extravagance caused by failure to coordinate public works—Federal, State, and local; bring about better programming of socially useful public works; prepare public works projects suitable, if desired, for use in emergency situations.

9. Provide for continuous long-range planning of land, water, and mineral resources in relation to each other and to the larger background of the social and economic life in which they are set.

It is, of course, idle to expect that the mere declaration of a set of policies will automatically produce such results. Legislation, administration, cooperation of many different types of government on many levels, and strongly supporting public opinion—all are necessary to bring about substantial changes of the kind just indicated. Nor can it be forgotten that the use of natural resources is not a thing apart, but involved closely in the whole mass of human activities, with industry, labor, finance, taxation. Natural resources planning is not planning at all, if it leaves out of account the many vital factors in our economic and social life, the resultant of which makes a standard of living.

It is the judgment of your Board, however, that the broad policies here outlined, would, if put into practical execution with the hearty and continuing support of the Government and the people of the Nation, lead to very substantial gains in the Nation's wealth and in the broad distribution of human welfare at which our national policy aims.

1. Land Planning Recommendations

A. *Continuous Planning*

1. That a *permanent Land Planning Section* of the National Resources Board or its successor be established, with an advisory committee consisting of representatives of the Federal bureaus primarily concerned and served by the secretariat of the Board.

2. That the *functions of the Land Section* should include:

(*a*) Action as a clearing house for all projects involving *purchase of land* by Federal agencies to prevent competition and to secure coordination with State and other plans.

(*b*) Recommendations on proposed *transfer of jurisdiction* over lands among Federal agencies, such as public domain, Indian reservations, grazing districts, forests, parks, etc.

(*c*) Advice as to coordination of *land management policies* to encourage consistent erosion control, wildlife, recreation, grazing, forestry, and similar policies on lands under the jurisdiction of different Federal agencies.

(*d*) Aid in coordination of *research projects* on land use to prevent duplication of research in different bureaus or overlapping of field investigations and demands on service agencies.

(*e*) Assist in negotiations between Federal and State agencies in developing land policies where Federal as well as State action is needed.

B. Needed Changes in Use

1. That a *land purchase program*, to secure more effective use of areas than is probable under private ownership, be undertaken over a term of years, involving:

(*a*) Continued *retirement of submarginal lands* at the rate of about 5 million acres per year for a period now estimated at 15 years.

(*b*) Additions to the *National and State forests*.

(*c*) Additional wildlife refuges.

(*d*) Additional *National and State parks* and purchase of areas within existing National park boundaries.

(*e*) Enlargement of Indian reservations.

(*f*) Squaring out or blocking up *delinquent tax areas* in cooperation with States enacting suitable legislation concerning State and county titles to tax delinquent lands.

2. *Land settlement policies:*

(*a*) That the *homestead and selection laws be repealed* to prevent new settlements of submarginal areas, and that the States be urged to take corresponding action concerning unorganized State lands.

(*b*) That the *classification of lands* according to problems and probable best uses be undertaken by Federal agencies in cooperation with the States, in order to designate areas unsuited to settlement.

(*c*) That *zoning and purchase of rights* by States and counties to promote best uses of land and prevent misuse, be encouraged through availability of Federal cooperation on purchase and other projects in preferred status where State action on zoning has been secured.

3. That *consolidation of some farm holdings*, as well as modification in type of farming should be sought through collaboration of the Department of Agriculture, Relief Administration, and Farm Credit Administration with State and local agencies and individuals.

4. That *tenancy* conditions warrant early consideration of legislation to provide compensation to tenants for improvements and immediate study of the larger problems involved with a view to formulating general policies.

5. That in relation to *subsistence homesteads*

(*a*) Early attention be given to providing types of credit necessary for an adequate system of land settlement, free from the restrictions inherent in funds provided primarily for relief purposes.

(*b*) No steps be taken to facilitate any considerable movement of unemployed people from urban areas into commercial agriculture.

(*c*) The integration of agricultural and industrial employment by the establishment of homes for workers employed in nonagricultural occupations where they may produce part of their living become a permanent national policy; and that this policy be broadened to include: Encouraging the location of industries, under proper conditions, in rural areas now seriously deficient in sources of income; reconstruction of existing rural industrial communities, which under laissez faire policies took the form of wretched homes huddled around a mine or a factory; planning for the integration of agricultural and industrial employment in the case of relocating industries; encouraging the location of industries on the periphery of large cities in definite relation to rapid-transit facilities to the countryside, as an important objective in city and regional planning; and developing the program of public-land administration with the definite aim of integrating employment on public lands with employment in agriculture.

C. Reclamation Policies

1. That in view of the scarcity of water in the arid sections of the country there be developed a well-rounded plan for the use of water, based on technological and economic considerations, and that there be State participation in planning and developing reclamation projects.

2. That the general national policy should be to complete and perfect old developments and to utilize them fully so far as practicable before undertaking new ones.

3. That consideration be given to facilitating the development of numerous small and seemingly unimportant irrigation operations, which, though essentially local in significance, in the aggregate are of considerable economic importance.

4. That no Federal project involving reclamation of land for agricultural purposes be undertaken until its economic feasibility and advantages have been considered by the Departments of the Interior and Agriculture, in conjunction with the coordinated planning agency already suggested.

D. Operating Policies

1. Grazing:

(*a*) That the provisions of the Taylor Act be extended to include such part of the unreserved public domain as may be primarily used for grazing;

(*b*) That advantage be taken of the exchange provisions of the Taylor Act to block up districts in public ownership; and

(*c*) That policies of the Forest Service and Grazing Administration be coordinated.

(*d*) That policies be formulated in cooperation with the States for State and Federal aids in areas where assessments are reduced or lands withdrawn from taxation due to development of extensive grazing operations.

2. Forestry:

(*a*) That forests under intensive management for sustained yields be greatly increased.

(*b*) That the State give consideration to a more scientific readjustment of tax burdens on forest lands.

(*c*) That public aids be continued for forest-fire control.

3. Recreation:

(*a*) That municipalities be urged to provide a minimum of 1 acre for recreation to each 100 persons.

(*b*) That States be urged to develop State park systems based upon comprehensive surveys.

(*c*) That the Federal Government's responsibility is chiefly to preserve superlative examples of scenery, historical and archeological sites of national importance, and primeval areas.

(*d*) That the Federal Government should cooperate with the States in making an inventory of historic sites and in establishing a central agency for selection and preservation of historic monuments.

(*e*) That the large recreational use of highways calls for more attention to roadsides and parkways.

4. Wildlife:

(*a*) That game policies of Federal agencies need closer integration and also the policies of the United States with those of the States.

(*b*) That one of the most important measures for the preservation and management of wildlife is the further extension of the system of public wildlife refuges, both for waterfowl and for upland game.

5. Indians:

(*a*) That the responsibility of the United States should not be to continue to support the Indians but to give them an opportunity to work out a more satisfying life.

(*b*) That appropriate steps be devised to meet the needs of the Indians for (1) additions to now available Indian lands sufficient to provide for those willing to assume the necessary responsibilities of land use, (2) an adequate system of credit, and (3) an educational system designed to fit them for operating land.

6. Erosion:

(*a*) That erosion control policies aim at establishment of control measures on all of the most seriously eroded areas in not more than 10 years and effective checking in not more than 20 years.

(*b*) That State cooperation be secured through enactment of regulatory legislation and active work by appropriate State agencies.

(*c*) That farm-mortgage credit and production-adjustment programs of the Federal Government be related to erosion control activities and conditions.

II. Water Resources Planning

1. That a permanent Water Planning Section of the National Resources Board or its successor be established.

2. That the functions of the Water Planning Section should include:

(*a*) To assemble promptly the basic data needed for planning the uses of water that now exist in scattered places, and that it initiate whatever researches are needed to provide additional data.

(*b*) To proceed as rapidly as is compatible with thoroughness to develop constructive programs for the uses of the country's water resources in the public interest, and for safeguarding that interest against dangers threatened by water.

(*c*) To make the fullest use feasible of the specialized knowledge and experience possessed by existing public agencies—municipal and State as well as Federal.

(*d*) To investigate water pollution in all its phases, including the effect of pollution on fish and other forms of aquatic life and organisms.

3. That the present Water Planning Committee make detailed engineering, social, financial, and legal studies of water projects in the following drainage basins:

(1) The Connecticut River project in Vermont, New Hampshire, Massachusetts, and Connecticut.

(2) The Delaware River Basin in New York, Pennsylvania, and New Jersey;

(3) The St. Lawrence, and the development of coal-generated, mine-mouth power in Pennsylvania.

(4) The Potomac River in Pennsylvania, Maryland, Virginia, West Virginia, and the District of Columbia.

(5) The Red River in Minnesota, North Dakota, and South Dakota.

(6) Missouri Basin, involving the Kansas City flood-control projects in Kansas and Missouri.

(7) Ohio Basin, in relation to the Pittsburgh flood-control project in Pennsylvania, New York, and West Virginia.

(8) The Kanawha-Greenbrier-New River in West Virginia, Virginia, and North Carolina.

(9) The Caddoa Dam and Reservoir on the Arkansas River in Colorado.

(10) The Conchas Dam and Reservoir on the South Canadian River in New Mexico.

(11) The Fort Reno Dam and Reservoir on the North Canadian River in Oklahoma.

(12) The Brazos Basin project in Texas.

(13) The Coldwater-Yazoo River project in Mississippi.

(14) The St. Francis project in Missouri and Arkansas.

(15) Colorado Basin

(16) The Central Valley in California.

(17) The Columbia Basin in relation to the Grand Coulee High Dam irrigation and power project.

That these studies be started as promptly as possible and prosecuted vigorously, with intent to reach early decisions concerning the wisdom of carrying out the projects in question. Further, that working plans for actual construction be made for those projects that are approved by the committee.

4. That studies for water projects and programs for adoption by Congress be prepared on the basis of drainage basins as wholes and consider a great variety of water and land uses and controls.

5. That further studies are needed concerning division of responsibility and costs among Federal, State, and local authorities.

III. Mineral Resource

1. That the Federal Government assist the mineral industries to attain economic stability, in order that they may minimize waste of natural resources, maintain reasonable wage standards and protect investments.

2. As means toward that end, careful consideration should be given to collective organization and action by the industries; industry control under public supervision of capacity, production, stocks, and sometimes of price; as guides toward the type of control adapted to different mineral industries, experience under the N. R. A. codes should be analyzed with care.

3. Before any type of control is authorized for an industry, that industry should be required to accept whatever safeguards are required to protect the interest of consumers, of wage earners, and the Nation's long-run interest in the conservation of its natural resources.

4. Each industry presents problems peculiar to itself. An effort should be made to adjust whatever controls are authorized to these peculiar needs and opportunities.

5. The situation of stranded populations dependent on mines now closed calls for prompt attention.

6. To make its efforts increasingly effective, the Government should promote scientific research relating to minerals, foster mineral technology, and provide a permanent planning agency to consider problems of policy.

IV. Public Works Planning

1. That a *permanent Public Works Administration* be established, based upon the powers, duties, and functions of the Emergency Administration of Public Works. The Federal Employment Stabilization Office should be merged with the Public Works Administration.

2. That the *functions of the Administration* should include—

(*a*) Preparation of a 6-year budget of construction or longer-range program of public works, revised annually, for submission through a Works Program Committee, to the President and the Congress.

(*b*) Negotiation of agreements with local, State, and regional authorities governing extent and method of Federal participation in public works projects within general limits to be prescribed by Congress.

(*c*) Allocation by the Administration of a lump sum appropriation among construction agencies, Federal, State, and local.

3. That a *Works Program Committee* be established to approve programs, negotiations, and allocations, and in general coordinate projects and programs from different points of view, such as unemployment and physical development of resources. The proposed committee should be in continuous contact with the proposed National Planning Board through the Board's secretariat.

4. That a series of advisory *planning committees* of the proposed National Planning Board be established for continuous study of public works projects, in such fields as water, roads, or buildings, and for the formulation of long-range plans and programs in cooperation with State, regional, and Federal agencies.

5. That legislative procedure on public works be developed as an extension of the well-established methods now used for rivers and harbors, public roads, etc., involving—

(*a*) Approval by Congress of a 6-year program or longer-range plan revised annually.

(*b*) Appropriation of a lump sum by Congress for allocation by the President among projects included in the approved program.

(*c*) Authorization by Congress for the Administrator of Public Works to negotiate and approve agreements with local, State, and regional authorities within limits prescribed by Congress and approved by the President.

V. State and Regional Planning

1. That the States be encouraged to establish permanent State planning boards and to develop as promptly as possible adequate State planning programs.

2. That continued cooperation with and encouragement of State planning and local planning work should be one of the primary obligations and activities of the proposed National Planning Board.

3. That assistance and encouragement to interstate and regional planning should constitute an important obligation of the National Planning Board.

VI. Basic Data for Planning

1. That a financial balance sheet for the Federal Government should be set up and maintained by the Comptroller General and that provision be made to make available to Federal agencies adequate similar statistics concerning States and municipalities.

2. That a mid-dicennial census of population and employment be taken during the next year, and that techniques be developed for reliable estimates of population and employment for the periods between the years when the Census is taken.

3. That standard maps of the United States be pushed to completion within 10 years as a Federal project with initial appropriations at the rate of fifteen million dollars annually.

4. That assistance be provided for basic studies relating to water and land resources, including climatology, soil erosion, soil classification, and ground water, and that gaging stations on rivers and other recording operations be extended to cover the principal streams of the country.

VII. Continuous National Planning

1. That an advisory National Planning Board be set up consisting of five members appointed by the President of the United States, to serve as a general staff for the Chief Executive.

2. That the functions of the Board should be advisory and not executive and should include—

(*a*) Coordination of planning policies within the Federal Government.

(*b*) Coordination of planning policies between Federal, State, and local jurisdictions.

(*c*) Stimulation and assistance to the planning agencies within the Federal Government and in regions, States, and localities.

(*d*) Fundamental research directed toward the development of basic national policies and programs.

3. That the staff of the Board under a Director be organized as a secretariat responsible for keeping in touch with planning agencies in departments and bureaus and serving as a liaison or agency with coordinating committees and special committees concerned with various aspects of national planning.

4. That continuing advisory committees, including representatives of Federal agencies primarily concerned, be set up dealing with long-time public works planning, land use, water resources, mineral policy, and mapping.

5. That an adequate appropriation of $ be made available for the work of the Board and included in the budgetary estimates for the executive officer.

PART I SECTION I
PLANNING THE USES OF OUR NATURAL RESOURCES

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SECTION I

I. Land Utilization and Land Policy

Introduction

The traditional American attitude toward land has been to develop and exploit it as rapidly as possible, with little regard for the consequences. This, to be sure, was the natural attitude of a new Nation reacting against the economic restraints of mercantilism and the remnants of medieval land tenure, and confronted with an apparently illimitable array of resources. This attitude contributed to rapid expansion and development, but at the same time produced a planless, crazy-quilt pattern of land use, destroyed or impaired a large proportion of the Nation's irreplaceable resources, and wrecked the hopes, aspirations, and the very lives of untold thousands of people.

In no other field of our economic activity has the doctrine of laissez faire been given freer rein than in the use of our agricultural lands. Farm lands have been used and abused and bought and sold as mere commodities, practically without restriction. Indeed, the extreme of laissez faire has been reached with respect to some of the Federal Government's own lands, on which unrestricted grazing has been permitted even to the point of destroying valuable range resources.

A gradual change in this traditional attitude has been under way for a generation or more, and has been somewhat reflected in land policies, particularly those relating to forests, but very little in agricultural land policies and in certain other segments of the land problem. The need for more study and definition of land policy led last spring to the creation of a Land Policy Section in the Agricultural Adjustment Administration. A beginning on coordination of land policies had previously been made through the Land Planning Committee of the National Planning Board, including representatives of the Agriculture and Interior Departments.

When the National Resources Board was assigned the task of preparing a report on land use for presentation to the President in the short space of 5 months, it naturally turned to these two existing agencies for help. A Land Section of the Board was set up under Dr. L. C. Gray, who as head of the A. A. A. Land Policy Section and through years of previous work in the field was recognized as a leading authority.

The Land Planning Committee continued as an advisory and coordinating group and later reviewed and revised the report which constitutes Part II of this volume. The Land Planning Committee consists of Dr. M. L. Wilson, Assistant Secretary of Agriculture, chairman; Oscar L. Chapman, Assistant Secretary of the Interior; Jacob Baker, Assistant Administrator F. E. R. A.; Dr. Hugh H. Bennett, Chief of the Soil, Erosion Service; Charles W. Eliot 2d, executive officer of the National Resources Board; Mordecai Ezekiel, economic adviser, Office of Secretary of Agriculture; Dr. L. C. Gray, Chief, Land Policy Section, A. A. A.; and W. C. Mendenhall, Director, United States Geological Survey.

The report prepared by Dr. L. C. Gray and revised by the committee is based on a series of more detailed reports prepared through the cooperation of a number of Federal agencies to which additional help was assigned by the National Resources Board. Besides the Land Section of the A. A. A., the Bureau of Agricultural Economics, Forest Service, Biological Survey, Bureau of Agricultural Engineering, Weather Bureau, and Bureau of Chemistry and Soils contributed to the report, together with the Indian Office, National Park Service, Geological Survey, and Soil Erosion Service of the Interior Department. From the Science Advisory Board help was forthcoming on scientific data for land planning. In brief, the report is the result of a cooperative effort.

The report of the Land Planning Committee published in this volume is in itself but a summary of the larger Land Report consisting of the data collected and analyzed by the cooperating agencies and organized by the director of the study, Dr. Gray. Many or all of these data, in itself a voluminous report, might appropriately be published after this document is released or transmitted to the Congress for its information.

The Land Report presents a complete reversal of the attitude of heedless and unplanned land exploitation. It reflects the point of view that public policy should aim at effecting such ownership and use of land as will best subserve general welfare rather than merely private advantage. The report, the most comprehensive ever made on this subject in the United States, takes stock of the probable future requirements for the various products and services of the Nation's lands, and inventories the available lands which may be used to satisfy these requirements. It points out glaring maladjustments in present land uses and proposes public policies for correcting such maladjustments and for directing land uses into the most productive channels.

OUTLOOK FOR POPULATION

As a Nation we have been long accustomed to count upon an extraordinarily rapid increase in population. We now find ourselves faced with the necessity of readjusting our economic system and the outlook for land requirements to the relatively early prospect of a stationary population, due mainly to the virtual cessation of immigration and the rapid decline of the birth rate. A careful analysis of population factors indicates that during the next 25 years the increase will be between 15,000,000 and 17,000,000, or no more than during the single decade ending in 1930. This assumes virtually no net foreign immigration, which has been negligible during the past several years. The prospect is for but little increase in population after 1960, and for a slowly declining population by 1970.

Cessation of foreign immigration and other factors are also materially affecting the age composition. During the next 25 years the proportion of the population comprising persons over 60 years of age will be approximately doubled. On the other hand, young people under 20 years will decrease by about as large number as the increase in persons over 60. Thus, the change in the two age periods of dependency will be in an opposite direction. There will be a little increase in the proportion of people in the intermediate, that is, the productive period of life.

The distribution of population between country and city will depend largely on the tendencies of rural-urban migration. If we assume the restoration of a volume of cityward migration such as prevailed during the decade ending with 1929, urban population will be nearly 20 percent larger in 1960 than in 1930, while farm population will have slowly declined. Assuming no net migration between city and country, urban population will increase less than 3 percent by 1945 and will then slowly decrease, while farm population will increase nearly one-half by 1960 and rural nonfarm by about one-fourth.

Important Relationship of Industrial Recovery to Land Utilization and Policy

The conclusions resulting from the two extreme assumptions as to urban-rural migration suggest the great importance of the outlook for industrial recovery in determining our course in land utilization and policy. It is probable that during the next 25 years progress in use of labor-saving machinery and in farming methods would make possible the production of our domestic supply and probable exports of farm products by a farm

Relief map of the United States.

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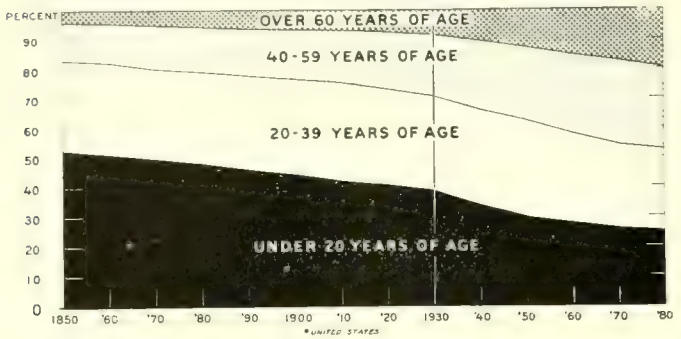
PROPORTION OF THE POPULATION IN VARIOUS AGE GROUPS, 1850-1930, AND THOMPSON'S AND WHELPTON'S "LOW" ESTIMATE, 1930-1980*

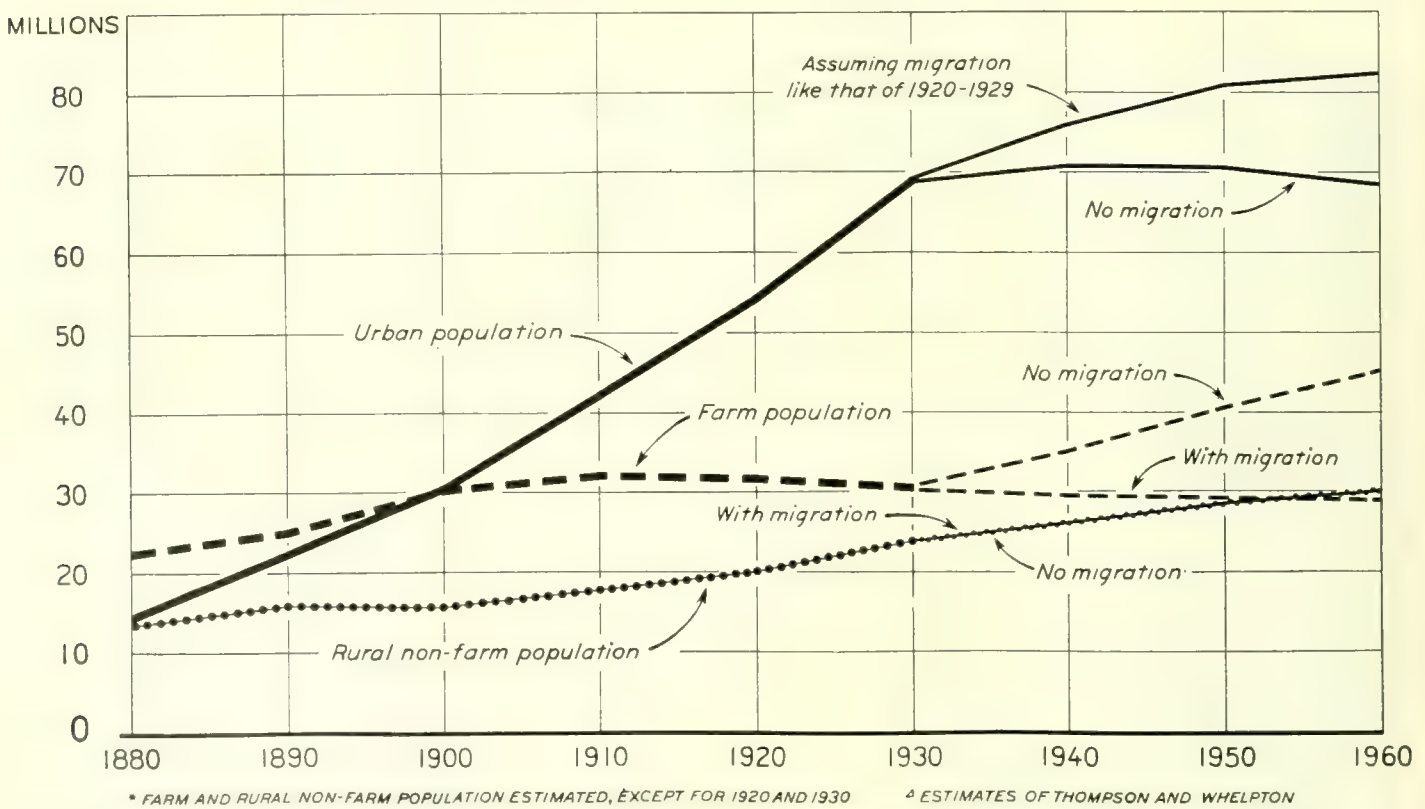


In 1870 over half the population was under 20 years of age, but in 1930 less than 40 percent. By 1950 these children and young people probably will constitute only 30 percent of the population and by 1980, or before, only 25 percent. In 1870 about 5 percent of the population was over 60 years of age. By 1930 the proportion had risen to 8.6 percent. By 1950 these old people will constitute 13 percent of the population, and by 1980 probably 20 percent. In 1870 about 45 percent of the population was between 20 and 60 years of age, which may be considered the productive years of life, taking the people as a whole. By 1930 people in these productive ages constituted 52.6 percent of the total population. By 1950 they will constitute about 57 percent, and by 1980 perhaps 55 percent. During the next few decades, when population will be almost stationary, a larger proportion of the population will be of productive age than in the past, or, probably, in the more distant future

population little or no larger than at present, as is implied in the assumption of a full restoration of migration to cities. The more serious questions would arise from the other extreme assumption of no rural-urban migration, and the resulting indication that our farm population, merely through natural increase alone, would be greater by one-half in 1960 than it was in 1930.

In all likelihood we shall make at least sufficient recovery in our national economy to avoid this last extreme. How soon, however, such recovery will occur and how completely it will permit the absorption of the population surplus now backed up on farms is a question of supreme importance. Already there are at least 3,000,000 more people on farms than when the depression began, and the natural increase of the farm population is estimated to average a half million per year. It is obvious that the continued increase of this abnormal farm surplus presents serious problems of land tenure, housing, farm employment, agricultural competition, and land utilization and settlement, some of which problems are discussed in the Land Report. (Part II.)

URBAN, FARM, AND RURAL NON-FARM POPULATION,* UNITED STATES, 1880-1930 AND ESTIMATES△ FOR 1940, 1950, AND 1960



* FARM AND RURAL NON-FARM POPULATION ESTIMATED, EXCEPT FOR 1920 AND 1930 △ ESTIMATES OF THOMPSON AND WHELPTON

During the half century, 1880-1930, urban population in the United States increased more than fourfold, rural nonfarm population (estimated prior to 1920) nearly doubled, and rural farm population increased scarcely a half. Practically all of this increase in farm population took place before 1910, little change in number occurring between 1910 and 1930. Looking to the future, and using Dr. Thompson's assumptions as to births and deaths, with no net immigration from foreign lands, it appears that the urban population, under the assumption of no internal migration, will increase less than 3 percent by 1945 and then decline slowly; rural nonfarm population will increase gradually until after 1960, by which year it will be about one-fourth larger than in 1930, while rural farm population will increase by about a half. But assuming the continuation of the 1920-29 migration, urban population will continue to increase until after 1960, by which year it will be nearly 20 percent larger than in 1930, rural nonfarm population will increase about the same as if no migration occurred, while farm population will slowly but constantly decline.

LAND REQUIREMENTS

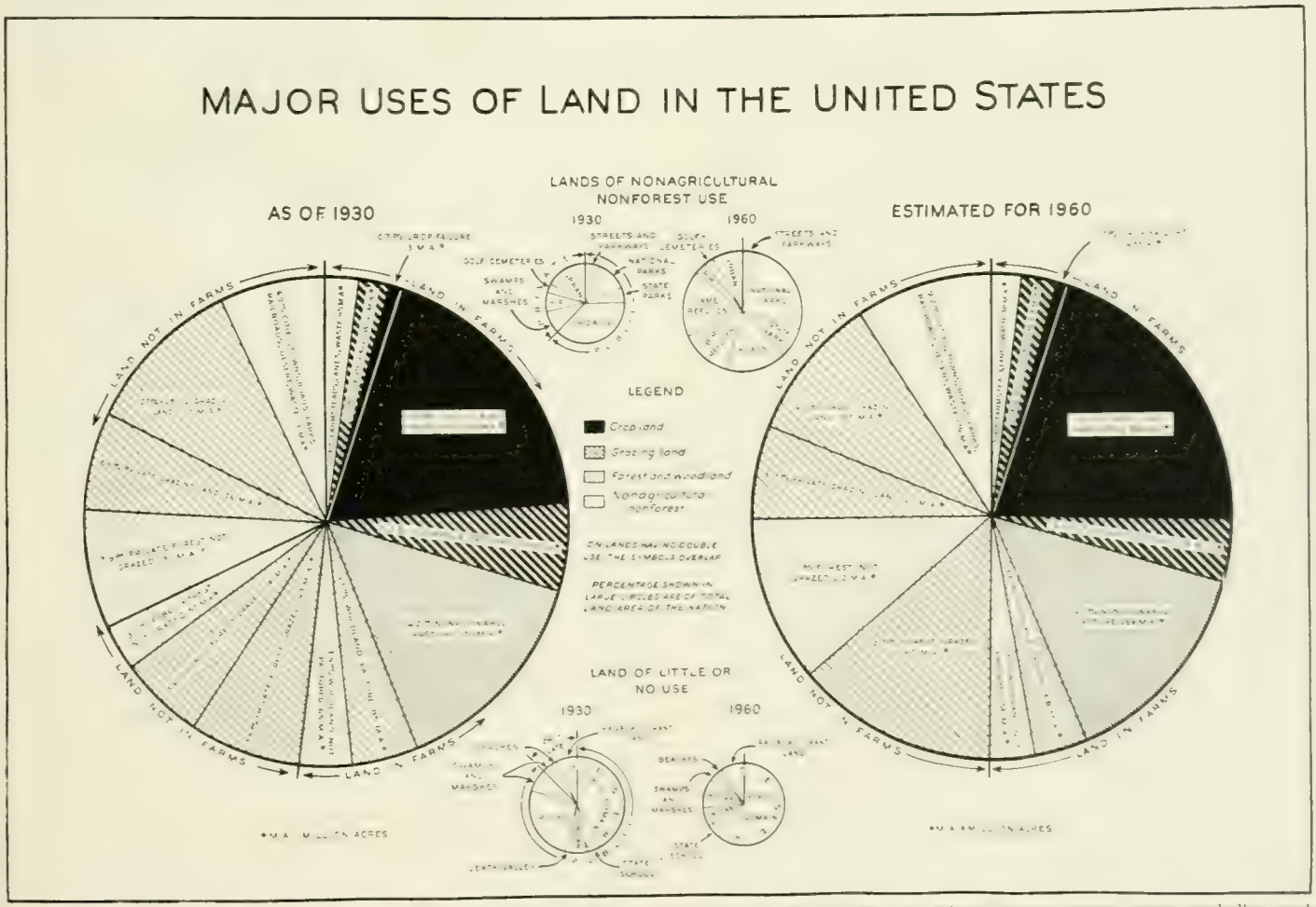
For Agriculture

The land surface of the continental United States is in round figures 1,903 million acres. Nearly all of it is capable of some kind of use, although relatively small parts are not now employed and large areas are inadequately or wastefully used.

The accompanying figure shows the present major uses of our land surface and also summarizes the uses 25 years from now as estimated in terms of requirements for various uses in relation to available land resources.

Meeting our requirements for agricultural products is a primary consideration. These requirements will be determined largely by prospective population, standards of consumption, foreign trade, and probable changes in yields and carrying capacity.

There have been notable changes in per capita domestic consumption of various farm products since the beginning of the present century. Nevertheless, when reduced to terms of land requirements, the per capita acreage of crop land required for domestic consumption of farm products has decreased about 2 percent from the average for the 5 pre-war years. Potentially, future changes in habits of consumption could exert a profound influence on agricultural land requirements. The Japanese, for instance, employ little more than one-tenth as much crop land per capita in providing for domestic requirements as we do; yet, with our much larger acreage millions of Americans have an inadequate and ill-balanced diet, especially lacking in milk, vegetables, and fruit. In part, this is due to poverty, but, perhaps, even more to ignorance and inertia. An adequate diet at moderate cost might be maintained on approximately our present per capita acreage. There appears to be little reason to anticipate, therefore, a material modifi-



A little over half of the land in the Nation is in farms. Of this land in farms, 38 percent was in crops in 1929 (including crop failure), 37 percent was in pasture (excluding woodland pasture), and 15 percent in woodland, the remainder being crop land lying idle, farmsteads, lanes, and waste land. All crop land is in farms, but the acreage of pasture, including range land outside of farms, exceeds that in farms. About 60 percent of this pasture land not in farms is publicly owned and 40 percent is privately owned. Nearly all this land is in the western half of the country and consists of range, mostly native, short-grass and bunch-grass vegetation adopted to the semiarid or arid conditions. In addition, much forest and woodland (over one-half) is grazed, particularly in much of the West and portions of the South, where the forest is quite open, permitting sunlight to reach the soil. The carrying capacity of this woodland pasture, like that of range pasture, is generally low. (See table 3.) The 53 million acres of land used for nonagricultural and nonforest purposes is small, but its value is great, particularly the urban land. Finally, there are about 77 million acres of absolute desert, bare rock, certain marsh lands and coastal beaches which are now valued at almost nothing, but have a social utility for wildlife and recreational use.

Looking to the future, it appears that the estimated prospective increase in population is likely to involve a slight increase in crop land, a decrease of pasture land and of forest in farms, if past trends continue, and increase in forest not in farms, more and more of which seems likely to pass into public ownership, and a notable increase in land devoted to recreational purposes. The increase in crop land will be the net result, as in the past, of decreases in some areas, mostly hilly or eroding lands, or sandy or infertile soils, and increases in other areas inherently more fertile or less exhausted of their fertility, or otherwise more productive, or which can be made productive by reclamation.

cation in per capita requirements of crop land for domestic consumption within the next 25 years.

Export requirements obviously depend in a measure on the choice we and other nations make with reference to foreign trade policy. Previous to 1929 we were exporting the products of 60 to 80 million acres of land, the greater part of which was in cotton, wheat, and corn, in the form of hog products (chiefly, hams and bacon). In 1932 we were exporting the products of only 43 million acres of land, and exports in the crop year 1934–35 will be even lower. An optimistic outlook would involve a slight increase of acreage for export, while a pessimistic point of view suggests no increase whatever, and possibly a small decrease.

While experience of European countries indicates a theoretical possibility of a great increase in productivity of our arable land, it would largely be at heavy expense. The analysis of trends and other considerations in the Land Report indicates that it is doubtful that we shall effect such economies in use of our arable acreage as would materially influence land requirements.

There has been no notable increase in crop yields for several decades. Progress in seed selection, fertilization, and other improvements has been more or less offset by the influence of soil depletion, insect enemies, and the crop diseases. The most important economies in the use of arable land have been through more efficient animal husbandry. Other reasons for not anticipating the meeting of our additional requirements through greater economy in the use of crop land is the fact that control of erosion will necessitate more extensive rather than more intensive use of some of the land, and the further fact that we shall not be subjected to the pressure to induce the adoption of intensive methods characteristic of more densely populated countries. Of course, it is extremely difficult to forecast tendencies of this kind, and it is always possible that epoch-making discoveries or more skillful land use may change our conception of future trends. On the other hand, increase in the use of more productive methods has been checked by the relatively low incomes from agriculture since the war. As demand increases and better balanced production brings about more satisfactory prices, the incentive to seek again more efficient methods of production, such as improved variety of seeds, more productive livestock, legumes, liming, etc., may offset the demands of increasing population. If all farmers were financed so they could use the efficient methods already proved practicable by the best farmers, the yield per acre from the arable area of the humid sections might be increased 30 or 40 percent at no great additional cost in the long run.

When all factors are considered the probable arable land requirements expressed as acreage harvested are estimated by our own experts as follows, in round numbers:

	Acres		Acres
1930	359, 000, 000	1950	377, 000, 000
1940	353, 000, 000	1955	383, 000, 000
1945	368, 600, 000	1960	386, 000, 000

If foreign trade fails to recover the requirement by 1960 might be 10,000,000 acres less. Associated with our harvested acreage there were in 1930 nearly 13,000,000 acres of crop failure, which varies with seasonal conditions, and 41,000,000 acres idle or fallow. The idle and fallow land includes a considerable acreage of summer-fallowed land in western dry-farming areas. Much of the "idle" crop land in the East is abandoned land on its way back to forest or pasture. If the same ratio of these two classes of land to harvested acreage continues, there is indicated a total theoretical acreage of crop land by 1960 of 430,000,000 to 444,000,000 acres (depending on foreign-trade developments) as compared with 413,000,000 acres in 1930.

Thus, it appears probable that we must provide for an additional 20,000,000 to 30,000,000 acres of crop land to meet our requirements in 1960, depending on degree of restoration of exports. Moreover, as indicated later, there are about 25,000,000 acres that should be retired from cultivation because of very poor quality or to prevent further serious deterioration. Thus, we shall probably find it necessary to provide at most for an additional 55,000,000 acres of arable land of average productiveness during the next 25 years.

It may appear strange that this forecast points to the need of increasing our arable acreage when during the present emergency there has been so much emphasis on reducing it. It should be noted, however, that the apparent excess of acreage has been due largely to a collapse of foreign and domestic demand; that the present arable acreage is not greatly in excess of our physical requirements; and that the forecast of needed acreage takes into account the requirements of increasing population. It will be noted that the forecast for 1940 is about 6 million acres less than the amount reported for 1930, and that no increase of acreage is shown before 1945.

In case the yield per acre of our crop land is seriously reduced by continued cropping without adequate rotation, and erosion takes its toll, and in case foreign demand is fully restored, it is probable that by 1960 we will require in order to take care of our domestic and foreign demand for agricultural products, new crop lands of at least the following amounts from the sources stated: 3,000,000 acres of irrigated land within the range of probable feasible cost, 10,000,000 acres through drainage, 10,000,000 acres of new clearing on the better quality of soils now in stumps or trees, and about 32,000,000 acres from plowable pasture.

Pasture requirements are more flexible than the requirements for arable acreage on account of the possibility of substituting feed crops for pasture. Our pas-

ture area has decreased since 1880 by about 189,000,000 acres, and since 1900 by 85,000,000 acres as a result mainly of conversion to cultivation, yet with no reduction in the quantity of milk and meat produced. This was possible almost wholly because of substitution of feed crops. In general the average productivity of our range lands has been decreasing for many years. It is widely recognized, however, that carrying capacity could be materially increased through better management. There has been and will continue to be some accretion through reversion of poor crop lands to pasture. The prospect is for a net decrease of about 30,000,000 acres of plowable pasture by 1960 and a small decrease in acreage of other pasture.

Forest Land Requirements

These cannot be judged merely in terms of needs for timber or other tree products. Forests are important for regulating stream flow, preventing erosion, and providing protection against wind. They provide a habitat for wild life, and have large possibilities for outdoor recreation. They are interrelated to agriculture and are an important factor in scenic, recreational, and economic interests of innumerable localities.

Timber requirements are influenced in a large measure by the available abundance or scarcity of timber and of the land available for producing it. A number of civilized countries where timber is unusually abundant have a larger per capita consumption, and others where it is scarce use much less than we do. It is a fair assumption that we would not be using so much timber per capita if it did not serve useful purposes, and therefore that we should provide for the maintenance of that volume of consumption if the land can be spared from other uses and if the costs do not outrun the value of the produce with due consideration for social values of forests.

On the basis of trends in consumption and the average consumption for years immediately preceding the depression, the Forest Service estimates normal annual future drain at 16,540 million cubic feet. This is but little more than the average drain just before the depression, but it is based on standards of consumption predicated on a comparative abundance and relative cheapness of timber products. If the general outlook, for a period of serious scarcity of timber is realized, this might result in material modifications in consumption standards, including the development and adoption of substitutes. These changes might continue into a subsequent period of greater abundance.

It was estimated that for the period 1925-29 growth amounted to only one-half the total drain. The problem of balancing growth and drain, however, is a function not merely of area, but also the management of the area as it may influence growth. Moreover, present growing "stock" is only about three-fourths of what would be required to maintain a sustained yield equal to the estimated drain, and is poorly distributed geographically.

The total forest area of the United States is 615 million acres, of which about 106 million consist of mesquite, pinon, juniper, and other arid woodland species. Of the remaining 509 million acres, only 495 million are held for commercial purposes, including farm woodlots.[1] A consideration of requirements for all major uses indicates that we may continue to employ this much land for forests and the various associated uses.

This is ample for any reasonable timber requirements, but at present much of it is either wrecked or on its way to destruction. The essential need, therefore, is for forest policies that will put our available forest area in condition to provide the various benefits which forests should contribute to national well-being.

Recreational Land Requirements

The measurement of recreational requirements merely in terms of acres would be obviously misleading. More significant are the character and accessibility of the land employed; and much depends on the type of recreation to be provided. Our magnificent system of national parks, for instance, is serviceable for only certain types of recreation and for a large proportion of our urban population is relatively inaccessible. Any program of land utilization must consider particularly the needs of low-income urban groups, for whom a program for recreational areas must provide open spaces near their homes: Either as small parks, in connection with school plants or in open courts of well-planned workers' housing.

We have a rapidly growing need for outdoor recreation due to increasing leisure resulting from changes in employment and the increasing proportion made up of residents of congested areas (prior to the depression). The provision of adequate opportunities for outdoor recreation is one of the most important forms of defense against antisocial influences.

In considering a program for the utilization of land for recreational purposes we again encounter the fact that land-use planning is dependent upon social objectives and institutions and upon plans for other types of development. The requirement for neighborhood parks and playgrounds depends upon the type of land coverage in projects for workers' housing and also upon the use of land in connection with school building programs. It would be a function of a National Planning Board to aid in integrating the plans of those separate agencies, both Federal and local, that are working in

[1] A small part of the 495 million acres will probably be required for new crop land and associated pasture, but this is likely to be more than offset by crop and pasture land that will revert to forest.

the fields of parks, school building and housing. For example, there is also a relationship between recreational land use and broad social institutions. In many countries by law, and to some extent in this country by individual arrangement, urban wage earners are granted vacations with pay. So also, especially in European countries, reduced rates have been developed to provide transportation for workers to the countryside. Any such trends should be considered in planning an extensive system of national parks or for preserving beauty spots. A primary concern of a National Planning Board as regards recreational land utilization should be the health and enjoyment of urban wage earners.

For the large proportion of our population in urban communities, municipal parks constitute the principal means of year-round recreation out of doors. In 1930, there were 308,805 acres in 1,072 cities with a population of 5,000 or more devoted to this purpose. A proper ratio of such facilities to population would necessitate at least double this area. A larger proportion should be in children's playgrounds and neighborhood play fields.

There may well be a considerable increase in the 100,000 acres reported for the 74 counties supporting parks, most of which are within metropolitan districts. A much larger number of counties should have parks of the natural area type.

It is also desirable to increase the number of metropolitan districts having organized park systems and particularly to provide more outlying recreational areas available for the use of industrial workers and the poorer class of children, for week-end and vacation use. These may be provided by the States when outside the corporate limits of metropolitan park districts.

State parks are visited annually by a far larger number of people than visit national parks, yet contain less than a fourth as much area. Few States at present have adequate park systems, though in some States this lack is supplied in large part by national forests and parks. There is notable need for well-planned systems of State parks, including such elements as large natural areas, parkways, small wayside parks, public beaches, numerous small camps, and picnic grounds. In the report of the land committee it is estimated that State and county park systems combined should be increased from the present 3,800,000 acres to as much as 10,000,000 acres.

The extensive areas in Federal ownership, including the public domain; the 15,000,000 acres in national parks, monuments, historic sites, and memorials; and the 130,000,000 acres in national forests constitute a vast potential though somewhat poorly distributed, recreational system, in most of which recreation is subordinate to other major uses. Certain additions should be made to the national-park system, mainly by transfer from other Federal administrative agencies. Prospective increases in national parks and forests in the eastern part of the United States will also enlarge the Federal area available for recreational use.

Land Requirements for Wildlife

The principal need for specialized wildlife areas consists of three principal types:

(1) Bird refuges, mainly to serve the needs of nesting areas and resting areas along migration flyways. Under the administration of the Biological Survey there are now upwards of a hundred refuges, mostly of this type, and an additional number aggregating upwards of a million acres is being acquired. Certain other marsh and swamp areas that can serve no other important purpose than for wildlife should be included in these refuges;

(2) Primitive areas where the fauna and flora may remain virtually undisturbed by man; and

(3) So-called upland game refuges.

The migratory-bird refuges will, in general, be areas specially acquired and administered for game and fish. The Biological Survey estimates that 17,000,000 acres of marsh and swamp lands should be provided with special wildlife administration. The second class will be provided in the main by specialized reservation and administration within national and State parks and forests. At present the national parks and some 25,000,000 acres within national forests have been given such specialized designation, of which about 21,000,000 are so designated by States. The upland game refuges will also be provided in the main as a coordinate use within publicly owned areas devoted to other major uses such as park, forest, and range lands. Sanctuaries will be only a part of this type, while much of it will be open to hunting under suitable regulations. The extension of the area of public forests and parks, including lands acquired under the submarginal land program, will be justified in part by the increased provision for this fourth type of game refuge and the associated recreational opportunities. Certain supplemental reservations from range lands to increase the winter range of wildlife in national parks and forests appear desirable.

MALADJUSTMENTS IN LAND USE AND PROPOSED LINES OF ACTION

General Nature of the Problem

With the exception of the unreserved public domain, most of the serious maladjustments apply to land in private ownership and grow out of the virtually unlimited powers of use and abuse which we have permitted in our system of private property in land. Basically, however, absolute ownership still resides in the State (either individual commonwealth or Nation), and under the police power the State may constrain the private use of land within bounds set by the public interest. Thus far in the rural areas there has been but little exercise by the State of its reserved rights in land. Considerations of public welfare may require a further extension of these rights. Some of these extensions are suggested in the Land Report.

Farm-Land Problems and Policies

The land consultants appointed to assemble field data for the Land Report were instructed to indicate on maps the location of the principal areas of serious maladjustments in farm land use.[2] While the maps are only rough approximations they do present a bird's-eye view of the extent and character of these maladjustments and afford a good starting point for the development of a more adequate land policy.

Submarginal Farm Lands

One of the outstanding types of maladjustment is what has been popularly designated as the problem of submarginal land—that is, areas where the land is so poorly adapted to farming or has deteriorated so seriously that nothing is in store for the inhabitants but extreme poverty and wretchedness. The accompanying figure shows the location of regions within which lie extensive areas where such conditions appear to justify a program of land purchase and removal of at least part of the present population to a more favorable environment. It is estimated that this should apply to a total of 75,000,000 acres of farm land, comprising about 20,000,000 acres of land in crops and about 35,000,000 acres of pasture. These areas are characterized by incredibly low standards of living. In some the soil is steadily deteriorating and conditions of life will continue to grow worse. All but a few of the areas are characterized by sparse population so that the cost of providing adequate schools and roads is excessive. In some of these areas a large proportion of the families are on relief and other social costs are high.[3] In the West these conditions are largely due to the indiscriminate occupancy of lands under the Homestead Acts.

[2] It has been possible to publish only a few of these maps in the accompanying Land Report.

[3] These conditions are elaborated in the Land Report.

Last spring a program for the purchase of these poor farms and for aiding the transfer of the families to other locations was begun through an allotment from the Public Works Administration, supplemented by drought relief funds appropriated by Congress. The program, which is being developed through collaboration of the Federal Emergency Relief Administration and the Departments of Agriculture and the Interior, is moving forward rapidly, and these agencies are engaged in plans for the acquisition of approximately 165 project areas containing a total of over 6,000,000 acres.

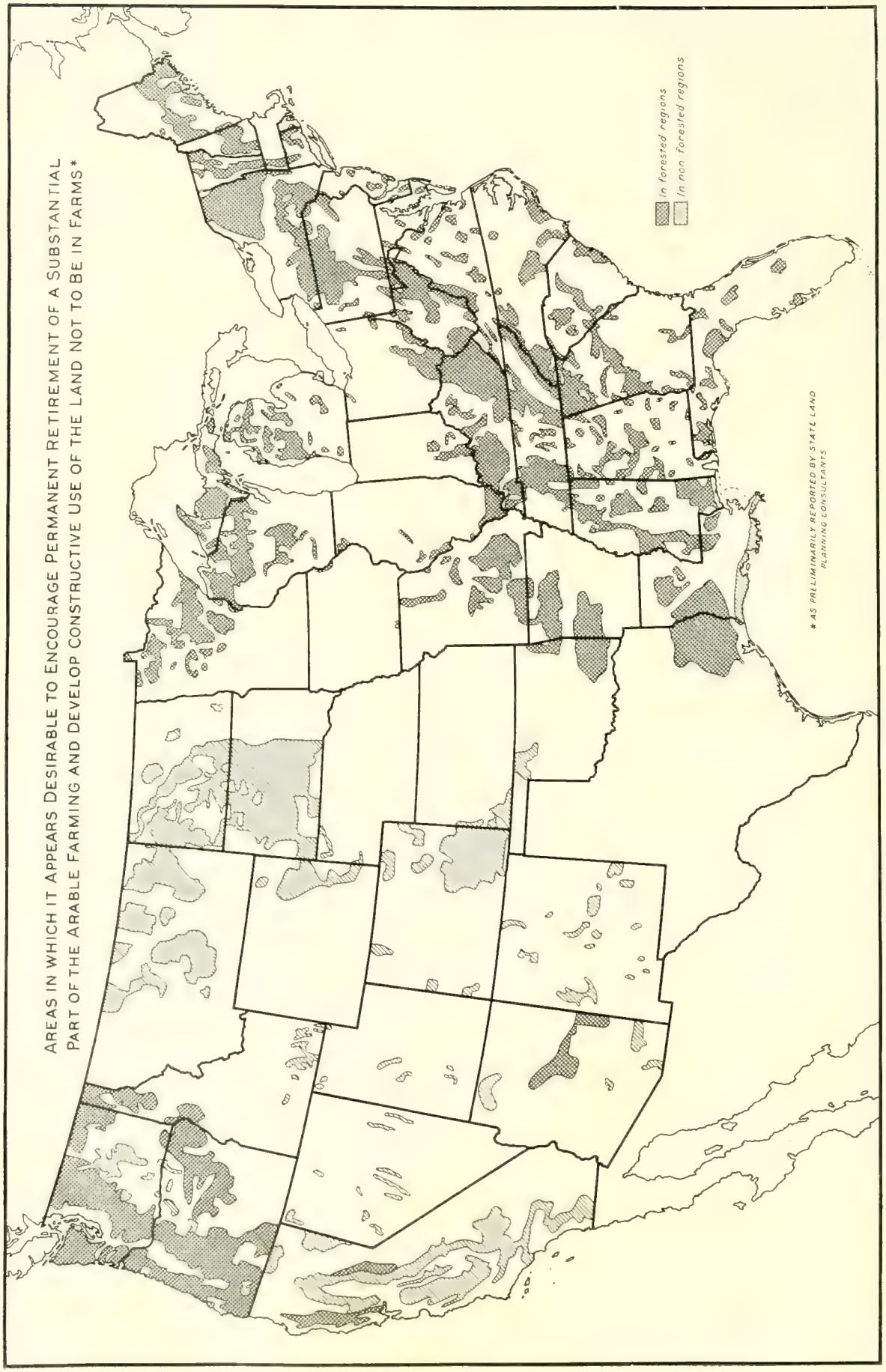
The lands acquired by the Federal Government will be included in adjacent national forests, parks, or wildlife refuges; will be leased to States for administration as public forests, parks, or wildlife refuges, when desirable; or will be formed into cooperative grazing districts when located mainly in range areas. Some of the lands will be devoted to meeting the land needs of the Indians.

Owing to the lack of opportunities for industrial employment, steps are being taken to resettle the families on better lands either with a view to farming as a mode of livelihood or to subsistence farming supplemented by outside employment. When industrial recovery is further advanced this part of the program can be confined to families who prefer to continue in farming. Experience during the current year has shown that, for the most part, the families in these areas respond readily to the program and that it is well supported by local public opinion.

It is believed that this program, with some modifications in procedure, should be continued as a gradual undertaking with a view to retiring these farm lands from cultivation at the rate of about 5,000,000 acres a year. At the present time the cost of acquisition, including administrative costs, runs from $5 to $6 an acre. Naturally this is somewhat above the average cost of purchasing cut-over forest land.

If the program is to be continued, certain modifications, set forth in the Land Report, should be given consideration, and steps hereafter suggested taken to coordinate the program with other Federal and State acquisition programs.

Soil Deterioration Through Erosion and Other Causes: Unquestionably one of the most acute problems of agriculture land use is soil depletion, which in many parts of the country is proceeding with startling rapidity. A careful estimate made for the Land Report indicates that on our crop and pasture land there is an average annual loss of 322,000,000 tons of organic matter and a net loss of 222,000,000 tons. Over half of this is due to leaching or erosion. (It was not prac-


AREAS IN WHICH IT APPEARS DESIRABLE TO ENCOURAGE PERMANENT RETIREMENT OF A SUBSTANTIAL PART OF THE ARABLE FARMING AND DEVELOP CONSTRUCTIVE USE OF THE LAND NOT TO BE IN FARMS*
In forested regions
In non forested regions
* AS PRELIMINARILY REPORTED BY STATE LAND PLANNING CONSULTANTS

Within these areas are farms from which arable farming should ultimately be encouraged to withdraw, mainly because experience has demonstrated the land to be too poor to provide adequate family living and support public institutions and services. Agricultural occupation of many of these areas continues only by grace of continual public subsidy or relief. Many of them are very sparsely settled and required public aid to help bear the high per capita expenditure for roads and schools. Most of them also have some land which should continue in agriculture. Further investigation will make possible a refinement of this map.

ticable to distinguish sharply the losses for these two sources.) It is estimated that usefulness for farming of 35,000,000 acres has been completely destroyed, that the top soil has been nearly or quite removed from an additional 125,000,000 acres, and that another 100,000,000 acres are starting in that direction. A detailed erosional map made for the Land Report, based on a reconnaissance survey, shows the widespread extent of this evil. (See the more generalized map, p. 290, Land Report.)

Erosion is responsible not only for severe losses in soil fertility, but also for the silting up of canals and reservoirs, the shallowing of navigable streams, and overlaying good soils with infertile material. Inadequacy of a protective covering on the land is responsible in large measure for damaging floods. Wind erosion, principally in semiarid areas formerly covered with range grasses, is causing serious damage.

Physically, the problem of dealing with erosion includes a number of steps. Where the evil has not gone too far, the most important measure is maintenance of an adequate cover, principally of forests or grass, although some crops are less contributive to erosion than other crops. It is possible to mitigate the evil somewhat, also, by such practices as contour plowing, strip cropping, and terracing. Where the serious gullying stage has been reached, it will be generally necessary to provide check dams.

Erosion is a serious economic problem. In some cases, to be sure, failure of private landowners to protect their lands is attributable to ignorance or inertia, and the remedy is education and demonstration. In the main, however, the failure is due to the fact that the other preventive steps require an outlay which the landowner does not feel justified in making.

Certain steps have already been taken by the Federal Government relative to the erosion problem. Systematic research as to character and extent and methods of control on different types of land is being carried on at a number of soil-erosion stations established by the Department of Agriculture. The Soil Erosion Service, established under Public Works Administration funds in the Department of the Interior, is engaged in erosion-control demonstrations on a national scale, embodying coordinate plans of erosion-control procedure in selected demonstration areas where the risks from erosion are high. The program is conducted in cooperation with the farmers, who contribute labor and teams needed. In the crop-adjustment program of the Agricultural Adjustment Administration certain provisions have been included to encourage the planting of soil-protecting crops on areas withheld from basic crop production.

These various measures, however, in their present scope, are not an adequate solution.

A national land policy should provide for the coordinated mobilization of all efforts, national, State, and local, to control erosion. It should aim at the establishment of erosion-control measures on all of the most serious areas within 10 years and effective checking of erosion in these areas within 20 years.

While it should be the aim to avoid imposition of legal restrictions to control erosion wherever possible, voluntary cooperation of private owners in erosion preventive measures will not always be possible to secure, and public assistance and control may be necessary in some instances. State legislation of this character might be encouraged through the extension of erosion-control aids to States enacting satisfactory regulatory measures.

In view of the interstate character of erosion problems, the Federal Government should assume responsibility for coordinating erosion-control measures, including its own activities along this line.

Legislation should be enacted to provide for Federal support to erosion-control measures on State and private lands. The Federal and the State Governments should acquire the most highly erosive areas on which control measures under private ownership do not appear feasible.

Federal farm-mortgage credit should be extended on the basis of the future value of the land, with due consideration to the possible effects of erosion.

In any production-adjustment program, increasing emphasis should be given to erosion control on lands retired from production of basic crops.

The Problem of Farm Consolidation and Land Tenure: In certain areas farms are at present too small to permit adoption of the kind of cover, mainly pasture, necessary to protect the soil and in some cases also to permit a generally safe and stable type of farming (see fig. 36). This problem is especially manifest in the Great Plains as a result of the operation of the homestead acts. Consolidation of some holdings, through purchase or leasing, as well as modifications in type of farming are needed. Debt readjustment will also be necessary and the resettlement of surplus population on other areas. It is in the main an undertaking in agricultural land planning that should be carried out through the collaboration of the Department of Agriculture, the Relief Administration, and the Farm Credit Administration with State and local agencies and individuals. With the exception of refinancing, such a program would require mainly funds for the investigational, planning and educational activities involved.

A large part of the responsibility for soil depletion and other maladjustments in agricultural land use must be attributed to our system of land tenure, which in turn reflects the influence of the speculative and migratory

habits of a large proportion of our population. In 1930 nearly 53 percent of our farmers operated some leased land, and nearly 44 percent of all land in farms was operated under lease.

Tenancy is not inherently contributory to robber farming. In many European countries tenants as a class expect to remain throughout their lives on the same farm and have a more or less material interest with the landlords in preserving and improving the farm plant. In this country a certain proportion of our tenants, mainly in the North, are relatives of the landlord and collaborate closely in a policy of safe and stable farming. Too many tenants, and landlords also, have little or no concern for the maintenance or improvement of the soil and the farm structures, or identifying themselves with community life. In fact the average period of occupancy by a renter is only a fraction above 2 years.

These characteristics of American tenancy are attributable in part to the migratory habits of our people. In large part, too, the system of landownership is at fault. Too many of the farm landowners, even including some who operate their farms themselves, expect to sell at some future date, and therefore have little concern for the deterioration of the soil. There is a good deal of speculative dealing in farm lands and a considerable proportion of our farm landlords are absentees. As a result of the depression a more than usual proportion of our lands is in the hands of creditor or Government agencies which have been compelled to take over the property. In the West North Central States nearly 30 percent of the total value of farm land was thus owned, in the East North Central States nearly 20 percent.

It is obviously not possible to correct all of these unfortunate conditions by legislation. However, it is high time that we should undertake seriously to deal with these problems. In the main the requisite legislative powers reside in the States rather than in the Federal Government, whose contribution may be limited mainly to leadership and stimulation, and possibly some financial collaboration.

One thing that should be carefully explored is the possibility of adapting to American conditions the policy of compulsory or semicompulsory compensation for improvements made by tenants, long employed in Great Britain and certain other countries, and certain measures for protecting competent tenants against the risk of unwarranted displacements. Such measures would greatly encourage both stability of occupancy and the protection and improvement of the farm plant.

There are many who believe that the solution lies in the direction of aiding all of our farmers to become landowners. The difficulty of approximating that position under present conditions is shown both by the present high percentage of tenancy in areas homesteaded only a few decades ago and by the impossible debt burdens or the high percentage of foreclosures of many who undertook to borrow their way to farm ownership. It is desirable to provide more liberal credit facilities than are at present available for those farmers capable of assuming the obligations and responsibilities of ownership. Obviously, however, liberal credit must be employed with great discrimination if it is not to prove a two-edged sword.

In view of the population prospect and other conditions, it is probable that there will be less farm land speculation in the future than in the past, and it is desirable to readjust the attitudes of farmers, tax assessors, and real estate interests which have led to an abnormal capital structure, now gradually being liquidated. We should deliberately shape public policy to check such land speculation as may arise. No doubt the wider sphere of influence of Federal credit machinery can be made to contribute materially to this end, and if necessary special forms of taxation might be developed for the same purpose.

In view of the serious import of these problems of land tenure, it is recommended that funds be made available to the National Resources Board at an early date to develop a policy and that in preparation therefor the Department of Agriculture, in cooperation with the various agricultural experiment stations, undertake the requisite exploratory work.

Land Reclamation: It was indicated in a preceding section (p. 12) on land requirements that, on the basis of conditions there outlined, during the next quarter of a century twelve or fifteen million acres of new arable land might be obtained by reclamation through drainage and irrigation projects. This necessity emphasizes the importance of developing a national land reclamation policy. Such a policy should be national in scope because intimately related to the economy of water use in deficit areas, to flood control and power policies, and above all, to the need for a planned provision fo our agriculture land requirements.

With the following recommendations of the Land Planning Committee the National Resources Board is in substantial agreement:

1. That in view of the scarcity of water in the arid sections of the country there be developed a well-rounded plan for the use of water, based on technological and economic considerations, and that nothing be allowed to interfere with such a plan.

2. That there be State participation in planning and developing reclamation projects.

3. That in case more than one State is involved and they fail to agree, the friendly offices of the Federal Government should be used to work out an acceptable policy.

4. That no project be undertaken until its economic feasibility or other necessity warranting its construction has been unquestionably demonstrated.

5. That the general national policy should be to complete and perfect old developments and to utilize them fully so far as practicable before undertaking new ones.

6. That consideration be given to facilitating the development of numerous small and seemingly unimportant irrigation operations, which, though essentially local in significance, in the aggregate are of considerable economic importance.

7. That, in the case of expenditure of Federal funds there should be a national benefit, as well as regional or individual benefit, and that not only farmers but also other individuals and the communities benefited be required to incur obligations commensurate with these benefits.

8. That no Federal project involving reclamation of land for agricultural purposes be undertaken until its economic feasibility and advantages have been considered by the Departments of the Interior and Agriculture, in conjunction with the coordinated planning agency hereafter suggested.

9. That in view of the serious mistakes made by uncontrolled private enterprise in the development of drainage and irrigation projects on the basis of speculative and promotional considerations, that the interests of farmers settling in such areas have been injuriously affected, that the Federal Government has subsequently been called upon to refinance such areas and to provide relief, and that some futile drainage enterprises have destroyed valuable refuges for wild life, the Federal Government should require the development of such projects to comprise an essential part of a national land use plan aimed at a proper coordination of the various major forms of land use so that the Nation may take the proper precautions to prevent the development of ill-considered projects and may direct agricultural expansion toward areas of lowest capital costs in relation to the utility of the land involved.

Public Policies for Giving Direction to Land Settlement: The above suggestions relative to reclamation policy serve to call attention to the need for a broader policy of direction to land settlement. It is obviously futile to undertake the retirement of poor farm lands and at the same time to permit the settlement or resettlement of other areas equally unsuited for farming. The farm-land market is overloaded with undeveloped land and the pressure of carrying charges is constantly urging the employment of high-pressure methods to effect the sale and settlement of such land and as a result to create new sore spots in rural areas. Both the Federal Government and the States have an obvious interest in preventing the continuance of planless land settlement which is seriously contrary to the general welfare as well as the welfare of the settlers themselves. The following recommendations are made with regard to this problem:

1. That the Federal Government put its own house in order in this respect by withdrawing from homestead entry and selective privileges all lands unsuitable for occupancy under the conditions of the acts. In part this has been provided for under the recently passed Taylor Act. The large volume of recent applications for entry, stimulated by unemployment, emphasize the need for such action. It is obviously inconsistent to be spending millions to retire submarginal lands in the very areas where homesteading is tending to place people in similar situations.

2. That States having considerable bodies of unorganized public land be encouraged to take similar steps to prevent the settlement of unsuitable areas.

3. That, in order further to support a public program of direction to land settlement, it is recommended that States pass adequate zoning enabling acts as in Wisconsin, and encourage localities to apply these acts to areas unsuited for agricultural occupancy.

4. That the Federal Government and the States cooperate in securing adoption of zoning laws outlining areas where settlement is clearly contrary to the public interest as well as to the interest of the individual settler. Both State and Federal agencies might also collaborate in directing settlement to areas adapted to the purpose.

5. That States modify their grants in aid of education, roads, and other utilities so that they may not stimulate unwarranted settlement of unsuitable areas.

6. That the Federal Government coordinate its credit and relief policies with a sound plan of land settlement in such way as to discourage the settlement of unsuitable areas.

7. That the States be encouraged to develop their legislation relating to real-estate transactions and their "blue-sky" laws where necessary to insure conformity with the general plan of land use referred to above, protect buyers and sellers of farm land from fraudulent and unscrupulous practices, and that the Federal Government further extend the administration of its postal laws so as to reenforce the administration of such State protective acts.

Policies for Facilitating Land Settlement: Although the record of organized public land-settlement exterprises as well as of private land-colonization enterprises in this country is not a happy one, the Federal Government is now embarking on an extensive program of land settlement. There are a number of conditions that emphasize the need for a definite national policy in regard to land settlement. One of these is the

necessity for the resettlement for persons now living on submarginal areas or areas where congestion of rural population is associated with farms that are unduly small to permit the type of farming requisite for soil protection. There are numerous families permanently stranded in rural industrial areas. Finally provision must be made for the rapidly increasing farm population and the formerly urban families which have voluntarily been returning to the land.

As has already been noted (p. 10) although rural population is expanding substantially, the existing farm population is sufficient to produce an adequate supply of agricultural products in the next 25 years. Ultimately this growing population must be absorbed in the production of industrial goods and services such as are now produced primarily in urban centers.

The existence of unemployment on a large scale in our cities makes it necessary to consider the problem of substandard farm families from both a short-run and a long-run point of view. Those wage earners now employed must be protected against the competition of a still larger number of anxious unemployed wage earners; nor is it conceivable that these families be added for long to the relief rolls. Means are being sought to better the condition of substandard farm families and of unemployed urban workers, even though it be impossible to afford them immediately that amount of income which our national resources and technical knowledge assure us eventually. These immediate and sometimes temporary measures should be conceived to contribute to, or at least not to conflict with, a larger ultimate solution of the problem. The following recommendations that lie within the field of the analysis of land use appear to warrant serious consideration:

1. That steps be taken for the more adequate coordination of existing Federal land-settlement programs, including the subsistence-homestead program, the rehabilitation program, and the reclamation program, and that the entire settlement program be fully coordinated with such broad plans of land utilization as are recommended in this report.

2. That early attention be given to providing types of credit necessary for an adequate system of land settlement, free from the restrictions inherent in funds provided primarily for relief purposes. The provisions of the so-called "Commissioners' Loans of the Farm Credit Administration" might well be broadened to make provision for their employment both in facilitating the progress of tenants to ownership and for Federal land-settlement programs.

3. That no steps be taken to facilitate a substantial movement of unemployed people from urban areas into commercial agriculture.

4. That the integration of agricultural and industrial employment by the establishment of homes for workers employed in non agricultural occupations where they may produce part of their living become a permanent national policy; and that this policy be broadened to include: encouraging the location of industries, under proper conditions, in rural areas now seriously deficient in sources of income; reconstruction of existing rural industrial communities, which under laissez faire policies took the form of wretched homes huddled around a mine or a factory; planning for the integration of agricultural and industrial employment in the case of relocating industries; encouraging the location of industries on the periphery of large cities in definite relation to rapid-transit facilities to the countryside as an important objective in city and regional planning; and developing the program of public land administration with the definite aim of integrating employment on public lands with employment in agriculture.

The following suggestions are made with reference to settlement procedure:

(*a*) That, in view of the very considerable uncertainty that industries can be induced to move to specific rural areas, it is desirable to proceed slowly in the establishment of agricultural settlements planned in the hope of, but without the assurance of, obtaining most of the money income from the establishment of new industries within the settlement area. Failure to accomplish the industrial side of the program would result in a new set of stranded populations living on agricultural units too small for commercial farming.

(*b*) That an elastic policy with reference to form of tenure in relation to the needs of the individual case be followed but with proper opportunity for acquisition of ownership in suitable cases. In many cases this will involve a considerable trial period on a leasehold basis and perhaps in some cases a continuance in that status, with provision for compensation for improvements made by the settler in case of change of occupancy. In order to prevent the misuse of settlement holdings for speculative purposes, recapture clauses in settlement contracts should be given due consideration.

(*c*) While it is important to avoid doing too much for settlers and to leave them full opportunity to employ spare-time labor in making their own improvements, adequate provision should be made for the training and guidance of many new settlers in agricultural pursuits.

The complete solution of the problem of raising the standard of life of all workers lies beyond the scope of this chapter on land. It involves a series of economic, social and political considerations with which a National Planning Board, as proposed later, would concern itself. At this point we note merely that a complete long-range outline of types of land utilization cannot be developed in isolation; it depends upon the broad economic and social policies of the Nation.

Range Policies

The serious consequences of the Federal Government's laissez faire policy in regard to the use of the

public domain have been so frequently pointed out that it is not necessary to repeat them.

The Taylor Grazing Act is a step toward remedying the situation. It was recommended above that all lands unsuitable for agricultural occupancy be withdrawn from entry and from selection privileges. It is further recommended:

1. That the regulation of surface use be extended to the remaining area of the public domain and to the 54,523,311 acres in the "withdrawn" and "unperfected entry" classifications now wholly unregulated, and that there be vigorous cancelation of unperfected entries long since past the 3-year period.

2. That the exchange provisions authorized under the Taylor Act be fully exercised to block up the area in public control.

3. Development of sustained yield management on State and county range lands, including lease and inspection provisions to assure reasonable compliance.

4. Collaboration of the Grazing Administration of the Public Domain and the Forest Service in the coordination of seasonal grazing.

5. Collaboration of interested agencies with the Agricultural Adjustment Administration to even out the cattle production cycle.

Forest Land Problems and Policies

Inasmuch as there is an available area of about 500 million acres for forest use without encroaching seriously on other important uses and in view of the fact that over much of this area there are important social values other than timber production which would probably justify the maintenance of a forest cover of some kind, the primary question is less one of how much land we should devote to forests than how intensively our forest management should be.

On the basis of a county-by-county survey, taking into consideration particularly the relationship of the forest to the life of local communities, the Forest Service has reached the conclusion that a relatively large proportion of the total forest area should be under intensive management and also recommends that a large proportion be devoted to public ownership and administration. These estimates are summarized in the following table:

TABLE 1.—*Acreage recommended by the Forest Service for various kinds of management, by type of proposed ownership*

Owner	Total	Intensive	Extensive	Protective
Private	231.2	113.3	81.9	36.0
Federal	291.7	131.9	54.7	105.1
State	68.5	46.6	12.3	9.6
County	3.8	2.3	1.3	.2
Municipal	.9	.5	.1	.3
Total	596.1	294.6	150.3	151.2

The area recommended by the Forest Service for public ownership is about 30 million acres larger than was recommended in the Copeland Report[4] and the area recommended for intensive management is very much larger than was recommended in the latter owing to greater emphasis on local needs in relation to forest management. Figure 53 in the Land Report shows the location of areas they propose for different types of management and figure 61 shows the location of areas recommended for the different forms of ownership.

These proposals for specific areas, which represent only the results of a very hasty survey, should be given further consideration in the gradual development of the forest program. It does not follow, however, merely because the interests of particular localities would be advanced in the immediate or remote future by intensive forest management, that either private timber owners or Federal or State governments would be justified in incurring the necessary cost throughout the aggregate estimated area. In all cases there should be a careful balancing of costs against the value of prospective returns including due consideration of the social values. Some of the important social values are not dependent upon either intensive forest management or even the production of commercial timber.

One of the most immediate considerations in forest policy is the protection of the existing forest area against the ravages of fire, insects, and disease. At present all but 190 million acres are under protection against fire, in large part due to the cooperative Federal fire protection program. (See fig. 55.) This program should be maintained and expanded to apply to such unprotected areas as justify the necessary expense. The protection against forest insects and disease is at present inadequate, and a considerable expansion of the public facilities for this function appears desirable.

The greater part of the forest area is still in private ownership. Over all but a small fraction of the privately owned land the process of systematically wrecking the forest continues, with all the demoralizing consequences to the dependent communities.

It is recommended that as rapidly as possible the Federal Government and the States take over through tax delinquency or otherwise for public ownership such wrecked or other areas as are clearly unsuitable for private ownership either because they hold out no promise of profit when managed in accordance with the principle of sustained yield or because there are associated with them social values which cannot be properly entrusted to the custody of private interests.

It is further recommended that certain measures be taken to provide more favorable conditions for private forestry, as follows:

1. Reconsideration and more scientific readjustment of tax burdens on forest lands.

[4] "A National Plan for American Forestry," Senate Doc. No. 12, 73d Cong., 1st sess., March 1933, recommends that 234,000,000 acres be acquired.

2. Public loans to private forest industries at low interest rates, on condition that operations be adjusted to sustained-yield management and reasonable safeguarding of other social interests in the forest.

3. Government aid in the construction of forest-road systems for fire protection and for public travel.

4. Public aid in fire protection and the control of insect and disease outbreaks.

5. In general public regulation requiring compliance with certain minimum silvicultural standards and sustained-yield management, provided that industrial self-government proves unavailing to realize these objectives.

6. Public acquisition (or exchange) of forest land and timber to aid owners who can benefit by liquidating part of their holdings and blocking up the remainder through exchange.

7. Reduction of the excessive volume of timber going to market, particularly on the Pacific Coast, which results largely from the pressure of carrying charges on private timber holdings excessive in relation to plant requirements. If this is to be accomplished by the industry itself it will necessitate material readjustments in indebtedness and in tax burdens, as well as the full collaboration of timber owners.

8. Ample provision of Federal aid to assist States in the distribution of forest-planting stock to farmers and to provide advisory service for the management of farm woodlands. It seems probable that similar services should be extended to other classes of owners, the public contribution to be shared equally by the Federal Government and the States.

Insofar as possible we should rely on industrial self-regulation for the development of sound forest management on privately owned lands adapted to such management. It seems probable, however, that a certain amount of collaboration by the Federal and State Governments with the administration of the industry will be requisite in order to bring nonconforming owners into line. With these ends in view, the following proposals are recommended:

1. Cooperation of the Federal Government and the States with the administration of the industry in maintaining adequate technical forces to review management plans developed by forest owners, particularly by the smaller owners, to inspect woods operations and production records, and advise as to forest practices.

2. Ample penalties for violations, enforceable under the police powers of the States or by a combination of State and Federal action.

3. Management of small holdings, farm wood lots, etc., to be integrated with a general program of planned land use through such public provisions as are recommended in this report for conservation of soil or farm lands.

It is recommended that the program of forest acquisition be fully integrated with the program for acquisition by other State and Federal agencies in accordance with the recommendations for coordinating land policies made hereafter in this report.

Development of the Nation's Recreational Resources

Although Government activities, as previously explained (p. 13), touch but a minor proportion of the recreational activities of the people, private recreational uses need governmental support and control to prevent such abuses as pollution of streams and unsightly placing of billboards, to prevent exclusive use of resources in which the public has an interest, to provide recreational facilities at small cost to low-income groups, and to preserve for succeeding generations certain areas and monuments of universal interest.

Municipal and Metropolitan Regional Park System: It appears desirable that municipalities of 8,000 inhabitants or over provide a minimum of 1 acre for recreation to each 100 persons, divided among play areas for children and adults, "in-town" small landscape parks, and larger park areas.

Cities, counties, States, and even the Federal Government have entered the field of planning for outdoor recreation in metropolitan districts without developing any definite standards or division of responsibilities. Planning for metropolitan area recreation should be on a unified basis.

State Systems: As stated in the Land Report, the responsibility of the States appears to be to acquire, develop, and maintain such areas as will meet the needs of their own people for recreation, as are not the responsibility of other governmental units. State parks, beaches, monuments, waysides, and parkways are examples of open spaces included in present State park systems.

State recreational systems should be based upon comprehensive surveys by qualified persons. Areas should be selected upon the basis of such factors as unusual or unique natural features or adequacy for the type of recreation involved. Boundaries should be wide enough to include all essential features and to prevent parasitic or unsightly border development.

The Federal System: The Federal Government's responsibility is chiefly to preserve superlative examples of scenery, historical and archeological sites of national importance, and primeval areas, which have been defined by the National Park Service as "tracts of virgin timber in which human activities have never upset the normal processes of nature." Primitive areas have been set aside in national forests and national parks, and include such specialized reservations as sacred

areas and research reserves. Many opportunities for making such reservations have been lost or diminished.

While the majority of historical sites should be preserved by the States, the Federal Government should preserve a limited number of unique significance. It should be the responsibility of the Federal Government, for instance, to preserve the archeological remains of Indian civilization. When of national importance such sites should become the property of the United States. The Federal Government should cooperate with the States in making an inventory of historic and archeological sites of the United States. A central agency of Nation-wide scope similar to those of France, Holland, Belgium, and England, for selection and preservation of historic monuments is needed in this country.

More than half the traffic over our highway system is recreational. While some highways devoted primarily to recreation are suitable for parkways, there is need for development of a type of trafficway of a character between the parkway and the highway. The policy of the Forest Service in leaving strips of timber along roadsides and on the borders of lakes and streams, and in locating its forest roads with due reference to esthetic values, contributes to the development of such trafficways and is to be commended.

The great and relatively unused recreation resources of our national parks and forests should of course be developed under a coordinated recreation policy including both State and Federal forests and parks.

A long list of proposed additions to the Federal park system has been prepared by the National Park Service. These additions would involve purchase of some property to establish new parks, or within boundaries of existing parks, but mainly transfer of jurisdiction over areas now administered by other Federal agencies.

A distinction should be maintained between areas set aside because of scenery, history, or natural wonders for inspiration and educational purposes as contrasted with areas producing timber or forest products, on both of which large recreational values can be developed without interference with their primary purposes.

Policies with Reference to Wildlife

The wildlife resources of the Nation provide meat and fur valued at almost 200 million dollars. Expenditures by hunters and by tourists attracted chiefly by an abundance of game aggregate over 400 million dollars. In addition, wildlife is of incalculable value in destroying insects preying upon agricultural crops and forest trees.

So far recognition of wildlife as a national asset has been centered on conservation, without regard to management. This has produced such situations as an overabundance of game in one region and a scarcity in another. The most serious situation, however, is still the depletion of the population of most wildlife species.

Game policies of Federal agencies need closer integration and also the policies of the United States with those of the States. Violations of Forest Service game regulations for instance should be made a violation of State law or of the Federal courts.

Private uses of land affect particularly agriculture and materially affect the small game population. Farm operations may either increase or decrease the food supply for game at different seasons of the year. Greater interest in game management by farmers could be stimulated by allowing them some proprietary rights in the game, which now usually are vested in the State.

One of the most important measures for the preservation and management of wildlife is the further extension of the system of public wildlife refuges, both for waterfowl and for upland game.

Indian Land Problems and Policies

The disorganization of ownership of Indian lands brought about by the Allotment Act (repealed through the Wheeler-Howard Act), which provided for allotment to individuals instead of continued tribal ownership, is now the most serious handicap to the Indians' effective use of their lands.

The most urgent present needs of the Indians are (1) additions to now available Indian lands sufficient to provide for those willing to assume the necessary responsibilities of land use, (2) an adequate system of credit, and (3) an educational system designed to fit them for operating land.

Gradual changes are in process in the educational system, and the Wheeler-Howard Act has provided the small beginnings of a credit system for the Indians with a $10,000,000 revolving fund. It has been estimated by the Indian Bureau, that it will require at least $50,000,000 to provide the necessary homes, livestock, and equipment to lift them to a plane of reasonable opportunity.

The land needs of the Indians as carefully estimated by the Office of Indian Affairs, shows on some of the reservations, present land acreages are adequate, while on others, there is marked shortage. Altogether, the Office of Indian Affairs estimates that 9,706,490 acres at an estimated value of $60,090,813, are needed for the Indians in excess of their present holdings and that there is a less urgent need for an additional 15,879,032 acres.

Some of this land could be provided from the public domain or from other Federal reservations, but a portion of it would have to be purchased. Toward a purchase program, $5,000,000 has already been made available under the submarginal land purchase program

for conversion to pasture, and the appropriation of $2,000,000 a year has been authorized by the Wheeler-Howard Act. With an appropriation no larger than this, however, it will require many years to acquire the 9¾ million acres. The Office of Indian Affairs recommends that the appropriations be increased to permit the completion of this needed land acquisition within a few years.

A part of the land requirements may be met by granting the Indians rights of use on the public domain or in the national forests. Certain white-owned grazing lands, which have been seriously over-grazed, might well be acquired now and allowed to recuperate for several years until the Indians have acquired animals to stock them.

The responsibility of the United States should not be to continue to support the Indians but to give them an opportunity to work out a more satisfying life.

Policies with Respect to the Public Acquisition and Ownership of Land

The Federal Government now owns over 400 million acres of land, and the States own about 70 million acres. Various proposals for Federal and State acquisition of additional land made by various Federal agencies aggregate almost 280 million acres, some of which, however, would be supplied from existing Federal holdings.

There are ten or a dozen land-acquiring or administering agencies of the Federal Government, whose programs are largely independent of each other. There has been little or no attempt to relate them one to the other or to State land policies. The need for coordination has been increased recently by the emergence of new agencies and new policies requiring public land acquisition. A Federal land-planning agency, whose organization and general functions are set forth in a succeeding section, appears indispensable in effecting such a coordination of the land-acquisition program of Federal and State agencies.

A Program for Permanently Tax-Delinquent and Tax-Reverted Land

Tax delinquency and tax-reverted lands demand a new approach in public-land acquisition.

The depression has brought on widespread tax delinquency even in the good agricultural areas, but with this type of delinquency, which is likely to disappear largely with the return of better times, this report is not particularly concerned. It is the chronic delinquency which has long existed in the poor-land areas, even before the present depression, which is creating serious problems. This type of delinquency is most common in the cut-over areas of the public-land States of the West and in the Southern States. In general, such delinquency is the result of clear cutting timber resources, settlement of farm lands unsuited for the purpose, and the resulting maladjustments in social and economic organizations in the regions of misuse. In a minority of cases, reasonable readjustments in taxation would help to eliminate delinquency. For the most part, however, wrecked forest lands, interspersed by scattering farms on poor land, are likely to present extensive chronic delinquency. In general the solution is for the States or the counties (in general the State appears to be the best agency for this purpose, although there are exceptions) to take title to such land with a view to generally retaining it in public ownership. A State agency should be established, or an existing agency designated, to administer the lands to which the State acquires title. Lands acquired by the State should be classified as to its best use as a part of a larger program for inventory and classification of lands in areas in which the best use is problematical. The Federal Government might assist in this program, through a wide variety of cooperative measures.

Requisite Procedure and Organization for the Development of a Unified Land Program

There has been no coordinated plan in the past for the utilization of our land resources. The policy of the greatest good of the greatest number should be the broad objective of land planning. Planning activity should be focused on areas of obvious maladjustment in land use. There should always be a goodly measure of elasticity in policy, organization, and procedure to meet changing conditions.

Although it would be desirable to have at hand a complete physical inventory of all land resources and an economic classification of all lands, it does not appear advisable to undertake so costly a program. It is desirable to locate the areas in which need for readjustment is urgent. A preliminary approximation has been made in the maps and surveys made for the Land Report. The areas should be subjected to more detailed study through more intensive field surveys undertaken with a view to specific action. As applied to specific areas, this will involve: (1) Adequate inventory of physical, social, and economic conditions, and their territorial and functional correlations and interrelationships; (2) compilation and analysis of such data, and derivation of working plans for them; and (3) administrative machinery for putting plans into effect.

Existing agencies and personnel should be utilized wherever possible. There are a number of Federal and State agencies with wide experience in land administration, investigation, and planning. There is wide

variation, however, in objectives and procedure as between individual agencies.

It is highly important to provide at once, if practicable, for adequate coordination of Federal and State land policies, programing, and procedure.

To secure Federal coordination of land administration it is recommended that the major division of responsibility between administrative agencies be by areas rather than by functions, i. e., centralized responsibility for all of the various functional aspects of land administration should rest with the agency responsible for the major form of land use within the area.

There is especial need for coordinating the land acquisition programs of Federal and State agencies in order that the pattern of public ownership and control may be symmetrical and specific areas of land be put to uses and types of ownership most consistent with the general welfare.

For the Federal Government these and other phases of integration of land acquisition and other land policies require the continuation of an extra-departmental agency such as the existing land-planning committee of the Board, authorized to make necessary and appropriate recommendations. This agency should be provided with requisite personnel and funds to enable it to provide the necessary coordination of our public-land policies, including land acquisition and allocations and transfers of jurisdiction over specific areas. The land-planning agency should provide leadership and initiative in order to determine the use which should be made of lands as viewed from the standpoint of general welfare, including what areas should be in public ownership, whether this ownership should be Federal or State ownership, and what governmental agencies are in best position to administer the land. Early attention should be given to areas in which there is serious economic dislocation, such as tax delinquency, idle lands for which no constructive use has been developed, submarginal farm land, and special areas proposed for public acquisition. The land-planning organization should not be responsible for acquisition or administration of land nor for administration of land policies. So far as practicable it should rely on the personnel and facilities of established agencies.

In the final analysis, land-use planning is of local as well as general concern because it must be locally applied, and the States should participate fully in land-planning programs. As in the Federal Government, the coordination of land-administration agencies within States is badly needed. The State planning boards should play the leading role in development of State land policies. For this purpose they might make use of institutions and agencies readily adapted to planning and which generally have been represented on the State planning boards.

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SECTION I
II. WATER RESOURCES

During the early stages of this country's development, water courses played a dominant role. River mouths afforded many of the best harbors on the coasts; river channels allowed the small sea-going ships of the seventeenth and eighteenth centuries to sail considerable distances inland; streams and lakes gave explorers and settlers their least laborious routes through the interior of the continent. In large part, settlement was guided by streams, and an appreciable part of the food supply consisted of fish. These resources could be used with trifling improvements. Rough piers, landing stages, and such boats as were used on rivers and lakes could be built quickly by ax-wielding frontiersmen. Even the water wheels that drove the early sawmills and textile factories involved no great outlay, for they were installed where nature had made the task easy.

When the settlements spread west across the Alleghanies, the population accustomed to river transportation bethought themselves of sending their produce to market by canals. Ambitious schemes of artificial inland waterways, encouraged by the success of the Erie Canal, caught the imagination of the country and swallowed investments huge for the times. Meanwhile, Robert Fulton's invention of the steamboat was making our greater rivers, such as the Hudson, the Ohio, and the Mississippi, the most important common carriers of the wide regions which they drained. River improvements became a matter of national concern, and the practice of voting large appropriations for such purposes outlasted the heyday of the steamboat.

As the railway net spread over the country, the importance of streams for transportation suffered at first a relative and later an absolute decline. Despite large expenditures for channel improvements, the freight moving up and down the Mississippi in recent decades has been smaller than the traffic of 60 or 80 years ago. It is only where large vessels can be employed in moving bulky freights, as on the Great Lakes, that inland water transportation has made gains or even held its own. Even in these cases the transport is carried on to an extent not generally realized by privately owned fleets of specialized boats rather than by licensed common carriers.

But while the rivers have declined in importance as transportation agencies, they have gained importance in other ways. They promise greater services and they threaten greater dangers. As the country has become more fully occupied by settlers, problems of water supply, flood damage, low water, sewage disposal, stream pollution, irrigation, drainage of low-lying lands, water power, stream crossings for railroads and highways, and the like, have become more pressing. Levees to protect fertile bottom lands have stretched to thousands of miles and grown progressively higher. Every new levee and every foot added to the height of old levees has increased the menace of floods to other lands. Cities have built aqueducts for hundreds of miles to reach watersheds that could be protected from contamination, and they get their electric current in many cases from waterfalls at similar distances. Towns, mines, and factories that used to dispose of their wastes by dumping them into river courses have been attacked by downstream dwellers for damaging their habitats, threatening their health and poisoning fish. Rival claimants to water for irrigation projects have brought their conflicting interests before the courts in hundreds of cases. Federal bureaus have been set up to care for both irrigation and drainage projects. Hydro-electric power presents another tangled problem which interests all citizens from the domestic consumer of electricity to the coal miner, the owner of public utility bonds, the industrialist looking for cheap energy, and the advocate of subsistence homesteads. Rivers that used to be great carriers of goods have become obstacles to the land roads of today—obstacles that must be spanned by bridges costing millions of dollars.

These illustrations suggest the complexity of the problems that face the country in making proper use of the water resources with which nature has endowed it so richly in certain regions and so sparsely in others. As the place of water resources in our national life has changed in the course of the country's past development, so it is likely to change further in the decades and centuries to come. The more interdependent we become as individuals and as communities, the more do we need to plan the uses of water with all our interests in mind. What was done on a lake or a stream in one settlement did not much concern other settlements a hundred years ago; it may change living conditions vitally in other districts today, and a hundred years hence the interdependence of interests will be greater than it is at present.

Nor can we confine attention to rivers, lakes, and harbors. Underground waters are the chief reliance of our population in many areas. These underground supplies are influenced to a degree that we cannot yet accurately determine, not only by the sinking of wells

NORTH PACIFIC DRAINAGE
RED RIVER DRAINAGE
GREAT LAKES & ST LAWRENCE RIVER DRAINAGE
NORTH ATLANTIC DRAINAGE
SOUTH PACIFIC DRAINAGE
MISSOURI RIVER DRAINAGE
UPPER MISSISSIPPI RIVER DRAINAGE
GREAT BASIN DRAINAGE
COLORADO RIVER DRAINAGE
SOUTHWEST MISSISSIPPI DRAINAGE
OHIO RIVER DRAINAGE
ALLUVIAL MISSISSIPPI RIVER DRAINAGE
EASTERN GULF & SOUTH ATLANTIC DRAINAGE
WESTERN GULF DRAINAGE
NATIONAL RESOURCES BOARD
WATER RESOURCES SECTION
LOCATION OF
PRINCIPAL DRAINAGE REGIONS
OF THE
UNITED STATES
Scale 1:25,000,000
Miles

and the rate of pumping, but also by methods of lumbering, grazing, tillage, and drainage that influence evaporation, plant absorption, run-off, and seepage into deeper strata. Rainfall itself seems to be affected by the cutting of forests, though here again we lack accurate means of determining the precise importance of human interference with natural processes. Certainly we are not justified in assuming that water resources will be constantly renewed by a bountiful nature in contrast to land and mineral resources which are depleted or exhausted by human use. The difference between the types of resources in this respect is a difference in degree only. In planning for water, the country must take a long view and think in terms of conservation as well as in terms of current use.

A fuller presentation of this many-sided problem of how to utilize our water resources to the best advantage may be found in the appended report of the water planning committee. The general objectives of this committee are defined as follows:

1. To develop more productive uses of water resources—power, water supply, navigation, power, irrigation, recreation.

2. To eliminate, modify, or neutralize harmful influences of waters, such as floods and erosion.

3. To eliminate, modify, or neutralize harmful handling of waters—pollution, waste through run-off and drainage.

4. To accomplish the above purposes effectively from the point of view of technology, geographical conditions, existing public agencies, and the intelligent understanding of good-willed citizens.

These objectives are considered with reference to representative regions, including:

1. The North Atlantic Basins.
2. The South Atlantic and Eastern Gulf Basins.
3. The Great Lakes and Red River of the North Basin.
4. The Upper Mississippi Region.
5. The Missouri Basin.
6. The Ohio Basin.
7. The Southwest Mississippi Basins.
8. The Lower Mississippi Region.
9. The Western Gulf Basins.
10. The Colorado Basins.
11. The South Pacific and Great Basin District.
12. The North Pacific District.

In the case of the Mississippi Valley region inquiry was extended over a considerable period of time and was pursued with greater intensiveness than in the case of the other regions.

The inquiry included water on the land and water in streams. Under the subject of water on land, the report deals with precipitation, run-off, infiltration, and evaporation. As to underground water, land-use zoning, and irrigation. Work upon the latter fields naturally overlapped that of the sister committee on land planning.

Under the head of water in streams, the committee deals with floods, low-water control, water supply and sanitation, navigation, and power.

In the Mississippi Valley report, of which Morris L. Cooke was also chairman, such topics as forestry and wild life, conservation, and recreation were included—again with far greater detail and more elaborate techniques than were possible in the report which covered the whole country.

The specific recommendations of the water planning committee include:

(1) Maps, surveys, inventories, and basic data.
(2) Experimentation and regional planning.
(3) Planning of specific projects.
(4) Legislation and administration—ways and means necessary for sound water planning purposes.
(5) Distribution of costs.

(I) Under the head of basic data, the Water Planning Committee recommends:

(*a*) The topographic mapping of the United States be pushed vigorously to completion.

(*b*) The present system of permanent gaging stations on all rivers concerning which records of flow are important for water resources planning, be extended.

(*c*) Appropriate inventory surveys of water resources of the Nation be undertaken systematically under unified Government auspices.

(*d*) Systematic, uniform land-use surveys of the country be initiated.

(*e*) Studies of the ground waters of the Nation be systematically pursued.

(*f*) The study of water supply and sanitation in relation to public health be promoted.

(*g*) Research in respect to water quality and standards be further promoted.

To this list should be added an item on the effect of pollution upon fisheries and wildlife.

II. Under the head of selective experimentation and regional planning, the water-planning committee recommends provision for surveys, studies, and experiments in selected unit areas. In this case it extends the proposal to include not only water but all other natural resources, such as land, forests, and minerals, together with the relevant economic and cultural conditions. At this point the recommendations of the water-planning committee should be associated with the recommendations of our land-planning and minerals committees. One region to be treated in this comprehensive fashion is the Ozark Highlands; but other areas are discussed, particularly in the more intensive report of the Mississippi Valley committee.

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III. Under the head of planning specific projects, the water-planning committee recommends that studies be initiated promptly in a long series of instances. As a partial but not complete list of such projects, the committee suggests the following:

(*a*) *North Atlantic Basins:* (1) The Connecticut River power, flood control, and stream pollution project in Vermont, New Hampshire, Massachusetts, and Connecticut; (2) The Delaware River power, water-supply and stream-pollution project in New York, Pennsylvania, and New Jersey; (3) A study looking to the coordination of the hydroelectric power to be developed in northern New York, principally in the international section of the St. Lawrence, and the development of coal-generated, mine-mouth power in Pennsylvania, having in mind condensing water requirements, so as best to conserve the social, economic, and industrial interests of the States of New Jersey, New York, and Pennsylvania;

(*b*) *South Atlantic and Eastern Gulf Basins:* (1) The Potomac River project in Pennsylvania, Maryland, Virginia, West Virginia, and the District of Columbia.

(*c*) *Upper Mississippi and Red River of the North Region:* The Red River water-supply and flood-control project in Minnesota, North Dakota, and South Dakota.

(*d*) *Missouri Basin:* (1) The Kansas City flood-control projects in Kansas and Missouri.

(*e*) *Ohio Basin:* (1) The Pittsburgh flood-control project in Pennsylvania, New York, and West Virginia; (2) The Kanawha-Greenbrier-New River flood-control, power and navigation project in West Virginia, Virginia, and North Carolina.

(*f*) *Southwest Mississippi and Western Gulf Basins:* (1) The Caddoa Dam and Reservoir on the Arkansas River in Colorado; (2) The Conchas Dam and Reservoir on the South Canadian River in New Mexico; (3) The Fort Reno Dam and Reservoir on the North Canadian River in Oklahoma; (4) The Brazos Basin conservation and reclamation project in Texas.

(*g*) *Lower Mississippi Region:* (1) The Coldwater-Yazoo River flood-control project in Mississippi; (2) The St. Francis flood-control project in Missouri and Arkansas.

(*h*) *Colorado Basin:* The interrelation of United States Colorado Basin projects in California, Arizona, Nevada, Utah, Wyoming, Colorado, and New Mexico.

(*i*) *South Pacific and Great Basin District:* (1) The economic aspects of the Central Valley irrigation, flood-control, power, and navigation project in California.

(*j*) *North Pacific District:* The Grand Coulee High Dam irrigation and power project in Washington.

IV. Under the head of necessary legislation and administrative organization, the committee on water planning recommends:

1. An exhaustive study of Federal and State legislation necessary to permit effective cooperation of Federal, State, regional, and local agencies in the conservation and effective use of water resources. (See the discussion of Jurisdictions for Public Works in another section of this report, page 62.)

The committee further advises improved standards and practices dealing with such subjects as the tolerance of industrial and mine wastes and municipal sewage in streams; the uses of subsurface waters and uniform principles governing drainage, forest practice, and reforestation. To secure proper coordination, the committee suggests the creation of an organization for advisory planning of the use and control of water resources.

V. Finally, the water-planning committee recommends the development of an equitable system of distributing the costs of water-resource projects, which should include not only private but social accounting—a striking revision of conventional costing technique. A more detailed study of this problem also is given in the report of the Mississippi Valley committee.

In outlining a policy for Federal participation, that committee says:

1. In general, Federal funds will be contributed to a flood-control project only where reasonable protection is afforded against floods of maximum height.

2. Federal funds as a rule will be contributed to a project, or to a principal unit of a project, only where the benefit from flood protection will justify the expense of such flood protection.

3. To projects of chief benefit only to local communities, Federal funds may be contributed to the extent of 30 percent of the cost of labor and materials.

(*a*) There must be a responsible and legally constituted local agency with which the Government may deal.

(*b*) Such local agency must guarantee the Government against any future claims for damages on account of the construction or operation of the project.

(*c*) Such local agency must provide all necessary land, flowage rights, rights-of-way, and similar items, as well as the remainder of the funds (in excess of the Federal contribution) required for completion of all essential construction work.

(*d*) Operation and maintenance costs shall be borne wholly by local interests.

4. To projects of substantial benefit to Federal interests as well as to local communities, Federal funds may be contributed in excess of 30 percent of the cost of labor and materials, the amount of Federal contribution in excess of such 30 percent to be determined by the proportion of benefits definitely applicable to a recognized Federal interest.

(*a*) Federal funds so contributed shall be expended under the direction of a qualified Government agency.

(*b*) There must be a responsible and legally constituted local agency with which the Government may deal.

(*c*) Such local agency must guarantee the Government against any future claims for damages on account of the construction or operation of the project.

(*d*) Such local agency must provide all necessary land, flowage rights, rights-of-way, and the like, as well as the remainder of the funds (in excess of the Federal contribution) required for completion of all essential construction work.

(*e*) Operation and maintenance costs shall be borne wholly or in part by local interests as may be determined in each case.

With the recommendations made by the water planning committee for more thorough examination of these engineering projects in their economic and social relations, the National Resources Board is in hearty accord. The water planning committee included several engineers from civil life and the Engineers Corps of the United States Army who have had long experience in dealing with water problems of many sorts; also a geographer, a forester, an economist, and a specialist in hydraulics. The membership of this committee was:

Morris L. Cooke, consulting engineer, Philadelphia, chairman.
Harlan H. Barrows, chairman of the department of geography, University of Chicago.
Herbert S. Crocker, consulting engineer, Denver, Colo.
Glen E. Edgerton, lieutenant colonel, Corps of Engineers.
Henry S. Graves, dean, School of Forestry, Yale University.
Edward M. Markham, major general, Chief of Engineers.
Charles H. Paul, consulting engineer, Dayton, Ohio.
Harlow S. Person, consulting economist, New York City.
Sherman M. Woodward, professor of hydraulics, State University of Iowa.

This group approached these problems with a variety of specialized knowledge about stream flows, water tables, dams, levees, irrigation, hydroelectric power, sanitary engineering, river transportation, floods, diversion channels, and the many other technical matters that must be considered. They had at their disposal the great collections of water data that have been gradually amassed by the Departments of War and Interior. To the study of water planning they have devoted more than a year of intensive effort, first as the Mississippi Valley committee and then as the water planning committee. A considerable staff of technical experts have been employed at their suggestion, and they have consulted with numerous interests both within and without the Government. This committee, working under such conditions, reports that before a long-range program involving large sums to be spent upon our water resources is adopted, further study of the many projects that have been proposed is indispensible to wise action.

The immediate need for gathering basic data that can be relied upon in developing a constructive program for promoting the general welfare of the country in the long run is clearly demonstrated. To proceed intelligently we must complete the topographic mapping of the country—obviously fundamental to plans for using a substance that runs down hill; extend the system of permanent gaging stations; make inventory surveys of the water resources available in different regions; study ground waters, water supply and sanitation in relation to public health, and set up standards of water quality. Besides these scientific data, we need also a more definite presentation of Federal and State laws that may help or hinder whatever plans for water use may prove to be socially desirable. And it is obviously wise in many cases to try out new departures experimentally in local areas before adopting them upon a large scale.

To see that the necessary data are gathered, that the legal arrangements for effective action are made, that the experiments are wisely designed, and that the lessons taught by these experiments are put to constructive use, the National Resources Board supports the committee's recommendation of "An organization for advisory planning of the use and control of water resources." There already exist numerous agencies in the Federal, State, and municipal governments that deal with certain aspects of water problems; what must be added for effective work is a coordinating agency that will consider all phases of the problem and all the regions affected in relation to the general welfare. Such a water planning organization would draw heavily upon the information collected by the older special and local agencies and upon their practical experience in dealing with separate phases of engineering and social problems. Further, the planning organization would suggest ways to use many of the now existing specialized agencies in carrying out portions of its general schemes. Until the country has some organization responsible for the continuous, systematic study of water uses in all their manifold aspects and in their bearing upon the life of every citizen, it will continue to spend huge sums for inadequate returns in well-being. The costs of such an organization as is suggested would make but a small fraction of the wastes avoided and of the gains secured by its work. This agency should be related to the National Planning Board which is recommended in a later section of this report, in the same manner as the agencies suggested for land and mineral planning.

While this recommendation implies that planning the uses of water resources should continue indefinitely, it does not imply that all construction work relative to water should be postponed to an indefinite future. Even on the basis of the present inadequate knowledge, it is justifiable to draw up a considerable list of projects that merit priority of consideration. The 17 projects

in 11 major drainage basins or regions [5] selected by the water planning committee and named above constitute such a list. All parts of the country are represented in it, and so also are all phases of water problems from transportation to stream pollution, flood control, municipal water supply, hydroelectric development, and irrigation. Even these projects are recommended by the committee for detailed study rather than for immediate execution.

It is highly desirable that large water projects shall be utilized as a means of furnishing employment in periods of extensive unemployment. At the present time employment can be furnished to men, who must be supported in some manner, in making the necessary explorations, surveys, working drawings, cost and benefit estimates, legal studies, etc., for the seventeen projects in the present list. It will be economical to provide whatever funds are available to the completion of this work.

Only after such exploratory work will it be possible to set large numbers of workers to construction. Without waste such works can be prepared for contract within a year or less. Prudence demands this immediate preparation of projects not only against the possible need of such public work next year, but also to furnish a backlog of available work in any other unemployment emergency. Water projects require substantial periods of preparation before they can effectively serve the worker's need for a stabilizing public works program.

The first requisite is the adoption of the general policy of planning the projects before congressional approval is sought, and planning takes time and money. In any planned program, first place must go to projects to which the Federal Government is already committed. These undertakings should be carried at least to a point of reasonable utility. The records of the various construction bureaus and the Public Works Administration provide the following estimates:

Federal water projects now under construction—Additional funds required

	P. W. A. allotments to Dec. 1, 1934	Requirements for fiscal year 1936	Requirements for completion
Reclamation	$76,700,000	$44,000,000	$103,950,000
Rivers and harbors	177,189,000	97,000,000	144,150,000
Flood control	51,233,000	56,000,000	104,900,000
Total	305,122,000	197,000,000	353,000,000

[5] Almost identical with the 10 basins selected by the President's Committee on Water Flow in April 1934, H. Doc. 395, 73d Cong., 2d Sess.

A second step is to distinguish between so-called "self-liquidating" projects and Federal projects upon which no direct return is anticipated. If self-liquidating is defined in terms of cash returns to the Federal Treasury equaling all or most of the investment made by the United States, then a substantial part of the funds committed on projects already started belong in that class. However, this distinction has a financial rather than a broad social significance; for projects do or can make returns in a great variety of ways and in greater or less amounts. The self-liquidating criterion is really a matter of accounting rather than of programming.

An alternative method of determining priorities is to collect from the Federal construction agencies lists of projects which, from their experience and knowledge, appear meritorious. With such a list a minimum of effort would sift out glaring inconsistencies or interferences among proposals. This is the old method of planning individual projects with little or no attempt at interrelation. The National Resources Board does not recommend this procedure except as an emergency measure when there is no time for adequate planning.

A better procedure is suggested by the studies of the President's Committee on Water Flow and the water planning committee which treat drainage basins as wholes and consider a great variety of water and land uses and controls. A natural result of this approach to the problem would be the selection or "programming" of a group of carefully related projects in a drainage basin or series of basins. What coordinated planning of a drainage basin may accomplish through the wise use and control of water resources can be demonstrated only by actual experiment.

A start has already been made in this direction in the Tennessee Valley, Columbia River Basin, and on the Colorado River; and plans have been prepared for the St. Lawrence and the Central Basin of California. In a number of other basins, as noted in the water planning report, plans have reached a state from which they can be brought into focus in a few months.

If the general principle implied in this procedure is agreed upon, it would be possible to select from the great variety of projects proposed by Federal agencies as filed with the Public Works Administration, items that would fit into any probable plan for larger basins. In this way an interim 1-year program—pending completion of a long-range program—could be developed in combination with the completion of projects already started.

SECTION I
III. MINERAL POLICY

1. The Planning Committee for Mineral Policy

Mineral resources have been a major factor in American industrial development. The country was endowed with a magnificent abundance and variety of minerals that provided cheap metal with which to make machines and cheap fuel with which to drive them. By the turn of the century, the United States had come to lead all other nations in both the production and use of mineral raw materials. In 1929 the mineral industries employed more than a million men and reported products to the value of 6 billion dollars.

For many years the country enjoyed the gifts of nature, secure in the belief that the horn of plenty would never fail. Warnings of impending shortage were sometimes heard, but new deposits were found and new methods developed. It was admitted that mineral resources were not reproduceable, but if new ones could be found, why be concerned for the future?

The first blow to the national complacency was the report of the Conservation Commission of 1908 which drew attention to the need of reform in the public land laws and to the huge wastes of the physical resources under prevailing methods of exploitation. The awakening of interest in conservation was followed by the World War, which revealed American dependence on foreign supplies of certain critical materials and at the same time stimulated production from domestic sources. Shortage of fuel, though caused largely by congestion of transport, made people acutely conscious of their dependence upon the mines and led to an elaborate machinery of war-time control. In coal, and in the metals, the war demand resulted in a great increase of productive capacity.

The overexpansion of war time was followed by a painful readjustment. In copper huge stocks held by the warring governments remained to be absorbed. In zinc, excess capacity built to meet the munitions demand had to be scrapped. In bituminous coal, the readjustment was accompanied by repeated strikes involving as many as 400,000 men and lasting as long as 5 months. Years of deflation followed in this industry accompanied by heavy financial loss and by sacrifice of labor standards. The oil industry, which continued to grow with giant strides, passed from one cycle of overproduction into another. Copper mining recovered from the post-war reaction only to find itself in 1930 faced with formidable competition from new fields opened abroad.

The difficulties of the mineral industries were brought to a crisis by the great depression. Metal mining—a handmaid of the capital goods industries—was prostrated. The oil industry struggled with a glut intensified by the phenomineal east Texas field. Coal mining saw the near collapse of the machinery of collective bargaining, and wages in some fields sank to starvation levels. The plight of the mine workers became among the most tragic of any section of our people.

A further effect of the depression was to intensify the existing waste of the underground resources. While great advances in mineral technology had occurred since the Conservation Commission of 1908 but little progress had been made in checking the resource losses associated with destructive competition and overdevelopment. With the coming of the depression, the loss increased. Some coal operators gave up the attempt to recover pillars. Waste of natural gas and overproduction of oil became more serious. In metal mining the collapse of prices forced many owners to "pick the eyes out" of their reserves and to abandon large tonnages of low-grade ore. Concern with the hardships of the mine workers and with the financial losses of owners was now reenforced by concern over the growing waste of the resources.

Acting on a suggestion from the Science Advisory Board, President Roosevelt, in April 1934, appointed a Planning Committee for Mineral Policy. The Committee was instructed to consider such questions as the estimating of future consumption, the curtailment of excessive production, the coordination of emergency appropriations in the mineral field, the relationship between Federal and State policy, the treatment of mineral resources on the public domain, the conservation of resources, and the effect of mineral tariffs—in short to undertake a general study of the mineral resources of the United States with a view to the establishment of a national mineral policy.

The membership of the committee included the Honorable Harold L. Ickes, Secretary of the Interior, as chairman; Dr. C. K. Leith, chairman of the department of geology of the University of Wisconsin, acting as a representative of the Science Advisory Board; Herbert Feis, Economic Adviser to the Department of State; J. W. Furness, Chief of the Minerals Division of the Bureau of Foreign and Domestic Commerce; Lt. Col. C. T. Harris, Jr., Ordnance Department, U. S. A., Director of the Planning Branch, Office of the Assistant Secretary of War; Leon Henderson, Director of the

Division of Research and Planning of the N. R. A.; W. C. Mendenhall, Director of the United States Geological Survey; F. A. Silcox, Chief Forester of the Forest Service; Wayne C. Taylor, Special Assistant to the Special Adviser to the President on Foreign Trade; Dr. W. L. Thorp, Director, Consumers Division, National Emergency Council; and John W. Finch, Director of the Bureau of Mines. A technical secretary, W. P. Rawles, was appointed and independent mining engineers were retained to make special studies.

Upon the creation of the National Resources Board, the Committee was also made the Mineral Section of the Technical Committee of the Board in order to care for the expenses of the Planning Committee for Mineral Policy and to assist the Board in its studies. The duties of the Committee are, therefore, twofold. Acting in its second capacity, the committee has contributed a section to this report of the National Resources Board. A later report, amplifying the findings in this preliminary statement, is in preparation.

2. Summary of the Report

In introducing its report, the committee calls attention to the importance of the mineral industry and to the fact that it has developed without the aid of any consistent national policy. The facts that warrant special consideration for the mineral industry and a unified policy for its guidance are: (1) That minerals are exhaustible and nonreproduceable; (2) that some minerals do not exist in the United States in quantities adequate for national welfare; (3) that others exist in present surplus; (4) that geographic distribution is fixed by nature and cannot be changed by enactment, thereby determining trade routes and trade areas, both domestic and foreign; (5) that there are special hazards, both physical and economic, in mining; (6) that closing down a mine may result in losses far more serious than closing down a factory.

The outstanding public question arising from these conditions is that of conservation, which is defined to mean not hoarding but rather orderly and efficient use in the interest of national welfare, both in war and peace, without unnecessary waste either of the physical resources or the human elements involved in their extraction.

It is pointed out that the application of improved technology has greatly reduced waste in operation and that the huge waste which still remains is attributable to destructive competition and over-development. Laws that forbid collective action between competitors have promoted waste, and, in the case of the petroleum industry, the law of capture has been strongly anti-conservational in its effect.

Proceeding in part II to the discussion of Policy in the Domestic Field, the mineral committee finds the central problem to be the wise use of the national inheritance for the welfare of labor, the industry itself, and the consuming public. The problem centers around the facts of limited occurrence and exhaustibility. Complete exhaustion is too far in the future to cause immediate concern, but the depletion of reserves to the point at which costs begin to mount rapidly is not far distant in some minerals and will handicap an industrial life that has been built upon abundance of cheap mineral raw materials. Waste must be reduced and technology improved.

Forecasts of consumption are necessary to prevent the over-expansion of capacity—one of the major causes of instability and waste. Forecasts have been of great value in the petroleum industry, but they have not been attempted by other mineral industries for a number of reasons. The forecasting agency should be a governmental body, probably the Bureau of Mines, acting in cooperation with representatives of producers and consumers.

Surplus plant capacity has been the chief factor in promoting ruinous competition which in turn has brought on wage reductions, loss of capital, and physical waste of resources. Recognition of the fact that mineral resource industries are in a class by themselves has led many thoughtful persons to support the idea of production or price control in some branches of mining, although opposing it when applied to manufacturing or trade. Whether by price-fixing, control of output, or other means, it appears that some method of eliminating excessive competition with its attendant waste is desirable, if carried out under the proper governmental supervision.

Bituminous coal has suffered greatly from over-expansion, and some form of stabilization is needed to protect labor and capital, and prevent waste of the resource. Under the N. R. A. code, the condition of the industry has been improved in some if not all fields, and majority opinion appears to favor the continuance of some form of control.

Price and production control, along the lines adopted in Europe, have been suggested for this country, although it is agreed that the application would be far more difficult here.

Capacity also will have to be controlled if any method of production or price control is to be permanently effective. Among the plans which have been proposed for accomplishing this are: (1) Guarantees of minimum employment to the miners by the operators; (2) that the Federal Securities Commission require promoters of new mines to publish full information on the economic condition of the industry; (3) that extensions of common-carrier railroads be disapproved by the Interstate Commerce Commission until public necessity is demonstrated; (4) purchase and closure of marginal mines by the Government, the cost to be defrayed by

revenues from a tonnage tax; (5) purchase of reserve coal lands along existing railroads to be set aside as a national coal reserve, also to be financed by a tonnage tax. These proposals are not specifically endorsed by the minerals committee, but are recommended as worthy of further study and consideration. If the coal industry really desires to check the expansion of capacity, the committee is convinced that the problem can be solved.

The importance of the petroleum industry to the country and the unsatisfactory state of the national reserves is indicated. Substitutes will be available upon the exhaustion of petroleum from wells but at prices that will handicap the national economy. The need of conservation is set forth with mention of the ways in which the greatest waste occurs and illustrations of its extent.

Attempts at control of oil production in the past have included voluntary curtailment and voluntary unitization. Under the present code, quotas have been allotted to the producing States, and unitization is strongly encouraged.

Desirable results that could be reasonably expected from the formulation of a national oil policy are shown and, although no specific recommendations are made, the general recommendation is that methods for controlling production and for unitary development of fields discovered in the future should be included in any plan adopted.

Copper is the metal industry suffering most severely from over-expansion. The boom activity of 1928–29 was partly speculative and the reaction has been thereby intensified. Unemployment is acute; whole communities of stranded miners must be rehabilitated elsewhere. Conditions are forcing resource waste through "selective mining" and premature abandonment; caving and flooding threatens loss of huge tonnages of low-grade ores. It is believed that the emergency measures adopted under the N. R. A. should be continued until the present excess stocks are liquidated. Long-time control over competition is desirable from many angles, including that of the public, if the proper safeguards are provided.

The committee believes that plans for stabilization should originate within the copper industry, but should include publication of full and complete statistics covering all phases of supply and demand, forecasts of consumption by a public agency, and a limitation on accumulating of excessive stocks.

Lead and zinc are both in positions similar to that of the copper industry, although their difficulties are less acute.

The committee's general recommendations as to production and capacity control in the mineral industries burdened with a present surplus of plant capacity are: (1) That the emergency provisions of the NRA codes for production control be continued in some form; (2) that in some cases, such as bituminous coal, provision for minimum and maximum prices may also be needed; (3) that action by Congress be considered establishing an agency to authorize control of production and capacity, and in special circumstances of prices, where uncontrolled competition is found to result in serious resource waste, with all necessary safeguards for the protection of the mine workers and consumers.

Turning from industries in present surplus to those for which domestic deposits are insufficient, the committee recommends that public encouragement should be given to exploration for new deposits, development of substitutes, and technological research for making low-grade supplies commercially available. Where domestic reserves are deficient tariffs have generally failed to bring adequate new supplies into being and instead have hastened the depletion of the inadequate supplies already known. A system of bonuses for discovery seems more desirable. The success of governmental agencies in developing supplies of potash and helium indicates the possibilities of systematic search.

The history of the administration and the present status of minerals on public lands is presented with a listing of the possible advantages and disadvantages of Government control and management under the leasing system adopted in 1920. The advantages briefly are: (1) A substantial revenue is collected in which the interested States share; (2) waste in mining is controlled; (3) adjustment of production to market needs is aided; (4) control of monopoly is aided; (5) safety standards are improved; (6) maintenance of reserves of essential minerals can be assured. The disadvantages are: (1) Increase of Government staffs and costs; (2) interference with freedom of action of citizens; (3) dangers to effective administration through withholding essential appropriations; (4) instability of policies under changing administrations; (5) chance of political favoritism.

The committee concludes that the advantages of the leasing system outweigh the drawbacks and that it should be extended, in much simplified form, to all publicly owned mineral deposits in the United States proper.

The committee approves the policy of retaining ownership of mineral deposits on public lands, but does not favor at the present time the general extension of public ownership over deposits of minerals that have passed into private hands. It favors the retention of the system of private operation, with Government supervision when necessary.

An exception to the policy of no general extension of public ownership may be advisable in the special case of bituminous coal, in which a proposal for the purchase of selected acreage as a means of controlling capacity

deserves serious consideration. Such a national coal reserve would be leased as needed with payment of royalty to the United States.

When mineral lands revert to the States through tax delinquency, the committee recommends that the States hold such lands in reserve until they are actually needed and then lease them under a system of royalty.

The question of submarginal mineral lands and mines is closely akin to that of submarginal agricultural land, although problems of readjustment become, if anything, more difficult, as mineral lands commonly have little or no value for other uses. Proposals to develop marginal deposits in order to relieve local unemployment must be weighed with care. The problem varies with the commodity involved; in the case of minerals for which we are still heavily dependent on imports, encouragement may well be given to development of marginal properties; in the case of minerals already burdened with a surplus of capacity, development of more mines will only displace existing production.

An opportunity exists for the National Resources Board, through its contact with the State planning boards, to foster or discourage local developments in the light of national interests.

After a discussion of Federal and local taxes on mines and on reserves, with particular reference to their effects on overdevelopment and resource waste, the committee recommends that further study be made of the question, especially of the ad valorem tax.

The importance of scrap metals at the present time and as a reserve against future needs is explained; and the committee recommends consideration of prohibiting the export of scrap of metals for which the domestic supply is deficient. It also recommends that more complete statistics concerning secondary metals be compiled by the Bureau of Mines.

The opportunity before the States to conserve their resources by exercise of their police powers in the prevention of physical waste is shown. The urgent need for such action, especially in checking the wastes of oil and natural gas, suggests a wide field of usefulness for State planning boards. It is recommended that the possibility of encouraging State action be given attention by the National Resources Board.

The committee reviews the functions of the scientific and technologic branches of the Government in the wise use of the country's mineral resources. The recommendations include: (1) Extension of areal geologic surveys; (2) more thorough inventories of reserves; (3) fundamental research in geology; (4) improvements in the technique of exploration; (5) improvements in the technique of mining and metallurgy; all of these require strengthening existing research agencies, coordinating private efforts, and exchanging information.

Progress in prevention of mine accidents is noted, but hazards to life and limb are still excessively high. Health and safety in mining are important from the economic as well as the humanitarian standpoint, and present a special problem. Federal work in this field should be maintained and strengthened.

After describing the present division of labor among Federal agencies dealing with mineral administration, the committee expresses the belief that the scientific, technical, and statistical services should remain in, and some of the fact-finding services in other departments should be transferred to, the Department of the Interior. The committee also feels that the fact-finding services should be under separate direction from the administration of mineral codes or production controls, but so articulated as to give the proper service.

Supervision of mineral codes involving control of production should ultimately be grouped under one agency, in order to facilitate the treatment of urgent problems of inter-industry competition, such as the competition between coal and oil.

An advisory coordinating committee, made up of representatives of all Federal agencies of mineral administration, should be continued, and a representative of this committee should sit on any general committee for natural resource planning created under the National Resources Board or elsewhere.

The committee urges that stronger support be given to the agencies dealing with mineral resources and calls attention to the disparity between funds alloted for agricultural services and mineral services.

Section III of the Mineral report is devoted to the international aspects of a mineral policy.

The necessity for international trade in mineral raw materials is shown and some of the measures, inspired by economic nationalism, that have been set up to obstruct the natural flow of trade are recited. A chart showing the position of the leading industrial nations with respect to the principal mineral commodities is included.

With respect to minerals of which the United States has a present exportable surplus, the committee recommends the following courses of action: (1) Give fitting consideration in negotiation of commercial agreements; (2) seek fair tariff and trade treatment by foreign governments; (3) maintain the Webb-Pomerene Act; (4) facilitate American participation when desirable in international cartels; (5) avoid artificial stimulation of exports by special concessions in freight rates or shipping subsidies not extended to other commodities; (6) discourage importations which aggravate anticonservational conditions of surplus development.

With respect to minerals for which the United States is largely dependent upon imports, it is suggested that

a wise policy should include: (1) Consideration of existing tariffs in the light of domestic reserves; (2) protection of American interests against attempts to maintain excessive prices on our needed imports, by the operation of cartels, intergovernmental agreements, export duties, or other restrictions; (3) restriction or regulation of the export of scrap; (4) establishment of war reserves of imported minerals essential for national defense; (5) maintenance of trading lines carrying these minerals.

After a statement of the minerals for which we are clearly dependent on foreign sources, points of policy with respect to national defense are set forth. It is recommended that stock piles be accumulated of these strategic materials not available from domestic deposits.

Tariffs for the reasonable protection of the branches of the mineral industry with adequate domestic reserves are probably justified. Tariffs that have been imposed on commodities with inadequate reserves generally have proved unsuccessful in bringing into production new sources of any considerable size. Study of these tariffs with a view to possible revision is recommended. Investigation of possible substitute measures for controlling importations is recommended, such as tariffs in kind, or import quotas.

The effects of international cartels are briefly described and it is suggested that the subject be given further study, since the cartels are of major concern both to American consumers and producers.

The extent of American expansion into foreign fields is indicated, along with some of the difficulties encountered. It is recommended by the Mineral Committee that the American policy in such instances should be directed along the following lines: (1) To preserve American property rights abroad; (2) to seek a balance between imports and domestic production that will best suit the general welfare of this country; (3) secure equality of opportunity abroad for our nationals; (4) give greater encouragement to the development of foreign supplies which we must import than to the development of those minerals possessed in abundance at home; (5) encourage fair relationships between American firms operating abroad and foreign governments and peoples.

The question of economic sanctions and boycotts receives reference but recommendations are withheld.

3. Special Recommendations of the Board

Reviewing the committee's report, the Board calls particular attention to the following points:

The immediate outlook, as far as the national resources in minerals are concerned, is for abundant supplies available at low prices, lower, in many cases, than those prevailing in the twenties. There is no sign that any serious limiting factor will emerge among the minerals to prevent the Nation from attaining a production of goods and services far above the levels of even 1929, say, for the next 10 years. The minerals for which we lack domestic deposits can be imported from abroad in any volume needed. The immediate problem of our major domestic industries is not a shortage but an unmanageable surplus, much like the surplus in agriculture. As in agriculture also, the surplus is resulting in heavy capital loss and depression of living standards. Few groups in our population have suffered greater hardships than the coal miners. Relief of these conditions is an immediate and pressing social problem.

The long-time outlook in the field of mining, on the other hand, is for increasing costs through exhaustion of the rich and more accessible deposits. The situation varies greatly in different minerals, but, in general, depletion is much further advanced than is generally realized. Known supplies of oil, natural gas, and certain of the metals (ores of present commercial grade) are sufficient for, at most, a few decades. Even in coal mining, the life of certain districts producing our finest coals is limited to about 85 years at normal rates of production. In both metals and fuels the reserves are sufficiently limited so that waste can no longer be tolerated. The long-time problem of the minerals is conservation.

At first thought the immediate problem of the surplus and the long-time problem of conservation seem to be in conflict. Actually they are due to the same fundamental cause—the destructive competition characteristic of scattered ownership and overdevelopment of productive capacity. Resource waste is most serious in those very industries with an unmanageable surplus. In oil and gas, the wastes are proverbial. At the present time in one field, enough gas is being blown into the air to supply all domestic consumers in the United States. In bituminous coal mining the avoidable loss is placed at 20 percent. Such wastes are seldom the fault of the individual operator who has small choice under existing competitive conditions. As described in the report of the technical committee, the wastes of fuel present a grave national problem. Avoidance of waste is partly a matter of technology. But very largely the prevention of waste is a legal and economic problem. As long as bituminous coal mining functions in surroundings of poverty, the operator has neither the incentive nor the means to prevent waste. The first and indispensible step to the solution of either the short-time problem of too many mines and miners or the long-time problem of preventing waste, is to place these industries on a basis of economic stability.

The States can do much in the prevention of waste. Through exercise of the police power, the States have the

constitutional authority to prohibit wasteful methods of mining, just as they have the authority to prescribe safety regulations. In the last 10 years, several of the States have made attempts to control waste in the production of oil and natural gas, which have in general been sustained by the courts. So far only a beginning has been made, but enough has been accomplished to show the possibility of replacing the wasteful rule of capture with a requirement of unitary development of the individual pool. In time, similar prohibitions of waste may be extended to coal mining. Progress in this direction can go no faster than the development of public opinion within the great mineral States. In the past, local opinion supporting such regulation has been held back by the depressed and profitless condition of many enterprises and by the competition between producers in different States. The slightest increase in production cost, caused by a local conservation law, might handicap the local industry. Similarly, the control of production by one State has been virtually impossible for lack of similar action in competing States, regardless of whether the purpose of control was to prevent waste of resources or to protect capital and living standards. The necessary prerequisite to encouraging action by the States is economic stability and some limitation on destructive competition between the States. Interstate compacts for this purpose should be encouraged, but are likely to call for complementary action by the Federal Government. In the mineral field, the problem of balancing supply and demand is essentially national and requires assistance of the National Government.

The chief service which the Federal Government can render in either the long- or the short-time problem is to assist the mineral industries to attain economic stability. Stabilization is necessary to preserve capital, to maintain reasonable wage standards and steadier employment, and to minimize resource waste. Stabilization requires a central organization and collective action. It may also require permitting control, under public supervision, of production, capacity, stocks, and sometimes of price, in ways which have traditionally been thought forbidden by the antitrust laws. Such control of competitive practices seems clearly necessary in the bituminous coal, oil, and natural gas industries. Some measure of control may also be found advisable in certain of the metals such as copper, lead, and zinc. In the case of oil, special legislation authorizing the fixing of State production quotas appears to be necessary.

Experience under the N. R. A. codes has shown the beneficial results of control and also the lines along which future action might be guided. Control of sales or of production is authorized by some of the metal codes; control of production and price is authorized by the oil code though up to the present production only has been dealt with. In the bituminous coal code the instrument of control selected is the minimum district price. Despite numerous shortcomings, which are summarized in the committee's report, the codes have yielded impressive benefits. In coal mining, especially, the control has kept prices above production costs, wages have been greatly increased, and employers, now able to pay the wage, have taken a different view of labor relations. In most of these industries, majority opinion appears to favor a continuation of some form of control.

The limited occurrence of many minerals is known to invite concentrated ownership, in some cases creating natural monopoly. In other cases, concentrated control is effected by control of patents, reduction plants, fabricating capacity, marketing facilities, or exceptional technical and managerial ability. Despite certain economies of centralized ownership, the consumer is right in feeling that unless an industry is operating under public regulation, competition is necessary to assure a fair price. While control of production and price presents grave difficulties in manufacturing and the service industries, the Board feels that it should be permitted, under appropriate public supervision, in natural resource industries where competition is known to be forcing serious waste, and where control can be shown to offer some improvement.

We therefore recommend that permanent provision be made to authorize control of competition after the expiration of the present National Recovery Act. We shall not attempt to outline the specific steps applicable in each industry, but, in general, the authorization should cover the control of production, of capacity, of surplus stocks, and where necessary, of price. The choice of specific methods of control is a technical matter, which should be left as far as possible to the supervising authority, acting in council with the industry concerned. From the point of view of the consumer the choice of methods makes little difference, since any minimum price, if observed, necessarily affects production, and any control of production necessarily affects price. The authorization of control should be made contingent on acceptance of whatever safeguards are thought necessary by Congress to protect the interests of the mine workers and the consumer, and upon assurance by the industry concerned that action will be taken to minimize resource waste.

It should not be the intent of such limitation to create monopoly profits nor to subsidize inefficiency; the consumer interest must be protected through effective representation. Equally labor must be protected in its right of organization, and advanced in its standards of living and of working conditions. Among the pressing needs of the workers is greater continuity of employment. The labor interest also requires and the

Committee recommends that the National Planning Board shall concern itself with the rehabilitation of stranded mining populations, presumably in connection with other programs for land utilization, construction or industrial development.

Supervision of such plans for production control could be lodged either under a separate mineral code division of a permanent N. R. A. or under a separate mineral industry division of the Interior Department. In the case of oil and coal, separate acts may be necessary to provide for special problems, such as crude oil quotas or purchase of marginal mines, but supervision should be placed under the same general auspices as other mineral codes. The important point, in the Board's view, is to recognize that the special problems raised by the waste of irreplaceable resources necessitate separate consideration.

To facilitate the adjustment of production to requirements, periodic forecasts of consumption should be made by a Government agency in collaboration with representatives of producers and consumers.

The Board further recommends that in any legislation for the stabilization of the mineral industries, consideration should be given to the possibility of retiring marginal mines now in operation.

To supplement the economic attack on waste, the Government should promote scientific research and foster mineral technology. The day of easy discovery of surface outcrops by the old-time prospector is past and the burden of overcoming the growing difficulties of mining falls more and more upon science and engineering. The great advances made during the last 20 years suggest the future savings which may be hoped for in this quarter. The invention of flotation has recovered great amounts of metal, formerly wasted because it could not be separated. Progress in oil technology has trebled the maximum depth of drilling. In power generation the fuel engineers have cut the consumption of coal per kilowatt-hour from 5.3 pounds to 1.5 pounds. The major contributions will doubtless continue to come from private sources, but the Government, through the Geological Survey and Bureau of Mines, should carry on fundamental research, testing and standardization; should aid in developing new methods of exploration such as use of geophysical instruments, and in improving methods of mining and metallurgy. Better maps and more thorough inventories of the national resources are needed. All these services should be maintained and strengthened.

Hazards to life and limb are still excessive, despite progress in the prevention of mine accidents. Since the welfare of the worker is the concern of all agencies of government, the health and safety of miners must be considered as part of any general plan. The task of those leading the safety movement is made easier because of the economic losses incident to hazard. Federal work in this field should be maintained and strengthened. The United States now has the highest mine accident rate of any country except Chile.

In addition to these immediate steps, there is need of continuous study and review of national policy in relation to the minerals, and of the results obtained. This might well be carried on by a permanent mineral policy committee working in cooperation with the National Resources Board. The present committee is already studying a number of special problems centering around mine taxation, tariffs, foreign trade, capacity, and reserves concerning which recommendations will be made later.

SECTION I
IV. HYDROELECTRIC POWER

Among the problems connected with the effective use of natural resources, none offer a more intriguing combination of splendid future possibilities and grave present difficulties than the development and distribution of water power. A power policy committee composed of Hon. Harold L. Ickes, chairman, and Messrs. Morris L. Cooke, Robert E. Healy, David Lilienthal, Major General Markham, F. R. McNinch, Elwood Mead, and T. W. Norcross is studying this field and will presumably submit recommendations to the President at a later date. Until that committee has completed its report, any detailed discussion of public policies relating to hydroelectric power may well be postponed. But the survey of the uses of land and water resources which the President directed the National Resources Board to make would be glaringly deficient if it paid no attention to this important topic. Accordingly we point out briefly certain major facts which bear upon the problem of planning for the larger use of water power.

1. In large part, the historical development of technology is the story of man's achievements in converting, controlling, and utilizing the energies latent in natural resources. Wind, water, coal, gas, and oil are all capable of being transformed into electric power—the most fluid and usable form known. Already electric power has become one of the basic determinants in our capacity to produce, distribute, and consume goods. The United States leads the world in the horsepower utilized per worker and in the units of electricity used. Much of our relatively high industrial efficiency is due to this fact. But further progress must be made in employing mechanical power if we are to realize all the advantages which science makes possible. Hence one of the objectives which national planning should strive to attain is to provide all sections of the country with all the electric power they may require at the lowest possible cost.

2. From the long-run viewpoint, the desirability of conserving natural resources makes the full utilization of all available water power seem highly desirable. Every unit of coal, gas, or oil burned is so much deducted from irreplaceable supplies. Water power, on the other hand, is a self-replenishing resource. Our rivers will continue to run so long as rains continue to fall and land surfaces are not worn down to a plain. No waste results from utilizing the power and no harm is done if the power installations do not damage esthetic values. Indeed, the power of a running stream is lost every minute that it remains unharnessed, whereas a ton of coal not raised today is available for use tomorrow or the day after. Nor does the use of water to generate electricity harm it for drinking, or bathing, or transporting goods—coal, oil, and gas are destroyed by burning.

3. From the short-run commercial viewpoint, the comparative merits of water and fuels as sources of electric power wear a different complexion. By virtue of (1) the great improvements recently made in furnaces and engines; (2) the low prices prevailing at present for coal, gas, and oil; and (3) the possibility of building fuel-electric plants near the markets for current and yet where fuels can be delivered cheaply, it is commonly less costly to provide electricity by combustion methods than by harnessing water powers and building transmission lines.

No marked gains have been made in water power generation since the turbine wheel was perfected, for the simple reason that under favorable conditions, the turbine converts about 85 percent of the energy of falling water into electricity—a percentage of conversion not approached even now by the most efficient of fuel-burning plants. Yet the advantage in cheapness lies decisively on the side of up-to-date coal, gas, or oil plants, when they are favorably located with reference to markets and fuel supply, provided that they can operate their furnaces continuously at an even rate. The great technical advantage of water-power plants is that they can be turned on for a few hours' work and then turned off again without much loss. Their place in the present technical scheme is mainly that of a supplementary source, used to carry peak loads for brief periods, while all of the load part of the time and the bulk of the load the rest of the time is carried by the economical fuel burners.

According to the 1932 census of electrical industries, 79 percent of the total electric-generating capacity of the country is fuel burning. The 21 percent provided by hydroelectric plants comes from the water powers which, all things considered, have seemed most profitable to develop. As matters now stand, commercial enterprises seem unlikely to push the development of water power much further in the near future. It is estimated that not more than about one-sixth of the country's water power has been harnessed; but the remaining sites are mostly expensive to develop, distant from markets, unreliable in flow, or undesirable in some other respect from the strictly commercial viewpoint.

The value of a water power project by itself depends upon what it can generate in times of low water or after a long drought. Even then it is necessary to draw down water impounded in the reservoirs sometimes leaving flooded shore lines seriously exposed if not actually pestilential in order to get the last drop of power from the plant. In recent years the idea of using cheap off-peak power for pumping back water into the reservoir has in a sense made a power reservoir fill the roll of a storage battery, but even so it is increasingly evident that water power and steam power must, economically speaking, be developed so as to complement and supplement each other.

4. Government development of water power cannot overlook considerations of cost and return; but it can take a broader and a longer view of the returns than commercial companies can afford to take. The Government is concerned with the question of conserving fuel resources, touched upon in paragraph 2 above, in a fashion different from private business. Also, in developing water power the Government should reckon among the gains any social benefits that may accrue to its citizens, though the benefits might yield no financial returns to a private company. Dams are erected in numerous cases to serve one or several purposes other than generating electricity; for example, to prevent floods, to prevent streams from running too low in dry seasons, to facilitate navigation, or to irrigate farming lands. Sometimes, though not always, the water stored behind these dams can be used for power without detriment to the chief purposes of the project. Under these circumstances, the capital cost properly attributable to the generating unit is, not the cost of the whole undertaking, but merely the extra costs of installing generators and transmission lines. Then a power project which would have been unprofitable, considered purely on a commercial basis, may earn a satisfactory return upon the cost allocated to the generating unit.

5. Another factor that government must consider is the social desirability of supplying electricity to a larger number of people than now enjoy the great aid to life. It is not necessary to enlarge upon the benefits conferred by adequate lighting, or the easing of labor made possible by the many electrical devices that have been invented for the household, the farm, the community, and shop. Though our people are the world's greatest users of current, only 13 percent of our 6,200,000 farms have electricity, whereas 64 percent of the farms have automobiles. There are villages not reached by power lines, and over wide areas the per-capita consumption of current is so low as to prove that the majority of families are doing without service though it is technically available. There is thus a vast potential demand for electricity that has not yet been tapped.

6. What keeps this potential demand from becoming effective are the relatively high charges for electricity that prevail in many sections. Recent studies of domestic consumption in low-cost municipalities demonstrate that the demand for current is highly elastic, expanding rapidly as the cost declines. The national average consumption of the United States was 604 kilowatt-hours in 1933. The average charge to consumers on October 1, 1934, for the whole country is reported as 5.49 cents per kilowatt-hour. In Seattle where the average cost is 2.58 cents the average consumption is 1,098 kilowatt-hours per capita. In Tacoma, the charge is 1.726 cents and the consumption 1,550. In 26 cities of Ontario, the average charge is 1.45 cents and the consumption 1,780. Finally, in Winnipeg, where the average net charge is only 8 mills per kilowatt-hour the average per capita consumption exceeds 4,000 kilowatt-hours.

It thus seems fairly certain that, if the average costs to consumers were substantially reduced in this country, a great increase in consumption would follow. Of course, this increase in volume of sales would reduce substantially the over-head costs per kilowatt-hour. Because of the large investments in generating plants, transmission lines, and distributings sytems on the one hand, and the moderate operating expenses on the other hand, overhead makes a far larger part of the total costs in electric-power utilities than in most industries. Doubling the use all but cuts the cost per unit in half.

7. The cost of serving a consumer includes the cost of generating, of transmitting, and of distributing current. Transmission refers to high-voltage lines which can carry the current long distances with relatively little loss; distribution lines start at "stepping-down stations" and carry current comparatively short distances at lower voltages to consumers. Reductions in cost of service may be effected at any of these three stages; but the stage of transmission, which ties together generation and distribution to consumers, seems to afford the best opening for systematic planning.

8. Experience indicates that marked economies are effected when interconnecting transmission lines are built to tie all the generating units and all the consumers of a wide area into one circuit. Without such lines, each generating unit and its market are isolated. The generating unit must provide for a peak load which is much higher than the average load. The interconnecting of many markets and many generating units makes it possible for the peak loads in different uses to offset one another in the course of 24 hours, so that the maximum peak load can be brought much nearer to total generating capacity than in the isolated unit. The total investment required for a given standard of service is thus greatly reduced by interconnection, and

with the investment the necessary charge to consumers is also reduced.

9. Considerable progress has been made in this country toward the creation of such circuits. Particularly noteworthy are the networks in the Southeastern, New England, East Central, and Pacific Coast States. On January 1, 1933, according to the census, there were 58,000 miles of transmission line operating in circuits at 66,000 volts or over. But large districts are still without such advantages. For example, in an area extending from Keokuk and St. Louis to Detroit (including Chicago and Milwaukee), it is reported that the installed generating capacity is 4,585,000 kilowatts, of which only 66 percent has been in use as measured by the maximum peak load. If 15 percent of excess capacity is taken as necessary to sound operation, then 1,086,000 kilowatts of the present installed capacity would not be needed to carry the present peak loads, provided all the generating units were tied into a comprehensive system. This excess capacity is estimated to represent an investment of over $108,000,000. That sum is included in the capital upon which the utility companies now base their rates. Studies of comparable areas in Pennsylvania, New York, and New Jersey indicate excess generating capacity over maximum peak loads ranging from 30 to 37 percent.

10. To sum up the outstanding factors which the Power Policy Committee has under consideration:

There are areas in the United States in which the power companies have excess capacity, in the sense that they cannot sell a large percentage of the power they can generate at the rates they charge. There are other areas, especially rural regions, which enjoy no electrical service.

Domestic and municipal consumption is at a level which indicates that a large part of our people go nearly or quite without the benefits which electricity brings to a family and a community. In this sense there exists a vast latent demand that is not being tapped at present.

The large per capita consumption in areas where the cost of current is low indicates that this potential demand would become effective demand if costs could be reduced.

In many areas interconnecting transmission lines would add greatly to the efficiency of operation and enable the companies to supply a much larger demand than at present without any additional investment. The critical question for such companies is whether the expansion in demand which might follow upon a reduction of rates would increase their net revenues.

The Government has an interest in extending the use of electricity as an increasingly significant item in the American standard of living. Hence it has an interest in the reduction of rates to stimulate consumption. It has a special interest in the development of hydroelectric plants as a means of conserving the country's resources in coal, gas, and oil. In some cases its plans for flood control, or other uses of water would enable it to provide hydroelectric power as a byproduct at slight direct cost. The Government will not fail to consider as a factor in the total situation the large sums of capital actually invested by power companies. The critical questions for the Government are how far the elasticity of the demand for electricity and the economies produced by interconnecting transmission lines may make it possible to reconcile these seemingly conflicting interests, and, to the extent that reconciliation is not possible, which interests should be given preference.

The National Resources Board enters these observations in its record, and awaits with lively interest the recommendations which the Power Policy Committee will lay before the President in due season.

PART I—SECTION II
PUBLIC WORKS PLANNING

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SECTION II
I. THE PROBLEM

Public construction in the United States increased during the first part of the last decade from a little over $2,000,000,000 worth per year to a high point in 1930 of $3,300,000,000, and dropped to a low point in 1933 of one and a third billions. This huge expenditure by municipalities, counties, States, and the Federal Government constituted approximately one quarter of the total construction bill—public and private—and almost a quarter of the total expense of Government averaged over the 10-year period.

How wisely did we spend that money? How can we secure a greater return for the 30-odd billions of dollars we seem likely to spend aside from emergency expenditures for public works during the next 10 years? How much could we wisely spend for worth-while projects?

A great variety of considerations must be weighed. What is a *public* work? What are the boundaries of the field and how are present trends likely to change our definitions? What criteria or standards have been set up to judge the value of different kinds of construction projects—both as between different kinds of desired things and as between different ways of doing the same thing? How can we maintain a proper balance of the program in relation to types of construction, timing, and location of projects?

A second series of questions involves the relations of public works to economic stabilization and the emergency problem of work relief. What part can public works play in meeting the problem of business cycles and how far can these works be made an instrument for recovery?

A third group of problems relates to the procedure followed by the Federal Government in the selection and execution of public works.

Finally, how is the distribution of public works affected by our system of local, State, and Federal governmental jurisdictions? Debt limitations and taxing authority complicate the problems faced, as well as conflicts of jurisdiction on projects which overlap political boundaries.

These and a great variety of other considerations have influenced decisions on public works in different ways at different times. Lack of understanding of the interrelations among these considerations has meant lack of policy and lack of leadership. Without a policy or a plan "pork barrel" methods of rough-and-ready decision inevitably control.

As a sample of planning work, the former National Planning Board selected *Public Works planning* as a strategic point offering large possibilities of planning accomplishment. With the allotment of a research fund from the Public Works Administration it authorized four exploratory investigations and has received the following in research reports:

1. Criteria and Planning for Public Works, Russell V. N. Black.
2. Public Works in Prosperity and Depression, Arthur D. Gayer.
3. Economies of Planned Public Works, J. Maurice Clark.
4. Government Organization for Public Works Planning, F. W. Powell.

From this material, and from information available to the board through the Public Works Administration and other sources, a report on Public Works planning was in course of preparation last June when the National Planning Board was merged with the Cabinet Committee on National Land Problems to form the National Resources Board.

SECTION II

II. TYPES, VOLUME, AND CRITERIA OF PUBLIC WORKS

General

The great variety of activities carried on under the term "public works" and the even greater variety of considerations upon which decisions regarding public works are customarily based are nothing short of bewildering.

The definition of public works is constantly expanding—both as to what is public as contrasted with individual or group activities, and as to what is work. The strict interpretation of work in terms of construction has long since been discarded as new public demands and needs requiring government attention have arisen. As a result a great variety of services are now included under the term, such as forestry, pest controls, surveys, and planning. The limits on growth of the public works field are measured in terms of public desires, national wealth, willingness to pay.

The research report on "Criteria and Planning for Public Works" prepared during the last year presents a variety of criteria which have differing applications to various types of public works.

1. The criterion of *balance*, including considerations of proper proportion between expenditures, within a limited budget, for the several kinds of public works and based primarily upon balance and proportion in the several services rendered.
2. The criterion of *service standards*, whereby deficiencies are measured by arbitrary standards of service established at or somewhere near the peak of actual accomplishment, plus reasonable probability.
3. The criterion of *essential services*, applicable to such basic needs as those of water supply, sewage disposal, and fire protection, with the chief determinant simply that of whether physical conditions and degree of population concentration make these services essential to community well-being.
4. The criterion of *cost*, including the following factors: Amount of total available income (dependent upon community wealth, upon public opinion, and upon public view as to what represents the real cost of public improvements); funds available for a given class of public works as determined by balance; and value to be received and benefit to be derived from a given project at a given cost, in consideration of all other needed improvements of the same class.
5. The criteria of *relative need* and *relative benefit* of individual projects in relation to and in consideration of all other needed improvements, as determinable by coordinated and comprehensive plan. These criteria are the determinants of sequence of projects.
6. The criteria of *trends*, and of growth and development potentialities, by which the extent and character of future requirement improvements and services may be measured. Such trends and potentialities in turn are determinable by exhaustive survey and analysis of conditions and trends, and by comprehensive long-range planning.
7. The criterion of *emergency*, with application varied according to whether projects involved are those for the replacement of necessary public works destroyed by fire, flood, or other catastrophe or whether these public works represent speeded-up execution of normal expansion of development of improvements and services.
8. The criterion of *social and economic desirability*, which for practical application must be based largely upon such arbitrary standards as may be established under item 2 above. (Many conceivable public works are quite without economic utility or social desirability, as determinable by applied common sense. The economic and social desirability of expansion of accepted and useful services is relative and in the last analysis limited only by public opinion and by limits set upon public expenditure by public opinion.)

These generalized criteria together provide a basis for planning—for the coordinated long-range plan itself is the summation of a series of just such decisions. Current practice in Federal, State, and local governments in the selection and programming of public works has little relation to the thoughtful application of "criteria."

Each type of public works involves additional special problems and individual projects must be judged in the light of special requirements over and above the general criteria listed above. Among the major fields where past experience has already indicated problems and possibilities a few examples may illustrate the point.

Public Works and Transportation

The largest single item in public construction for a number of years has been for streets and highways. Unfortunately, for a large proportion of this work no comprehensive plans related to other factors of State and National development have been available. The economic justification demanded by the Bureau of Public Roads for Federal-aid projects and extensive traffic counts have provided against much waste but are hardly adequate as tests after the primary system of roads is established. Furthermore, arbitrary limitations on Federal aids to roads in respect to State mileage, mileage of rural post roads, area and population have sometimes unbalanced the program in relation to primary needs and Federal interests.

Since much more highway and street work is not only probable but in many cases desirable, it is important to

have plans ready to secure the full value for the money to be spent. The failure to look ahead to new needs and new developments is illustrated by what occurred in at least one State which put out a large bond issue to build highways. It proved an extravagant project because the work was rushed forward without sufficient advance study, and many of the highways then built are being rebuilt at considerable expense, first, because the original highways were badly located; second, because the art of road building had not been developed to a point that experience soon indicated was necessary; and, third, because the roads were crowned rather than flat. Although this was a notable, perhaps a flagrant example, it is not at all an unusual experience.

The primary network of highways for the United States is now well advanced with hard-surfaced and year-around road facilities for a large part of the more densely populated portions of the country. There is even talk of the possibility of over-building highways—chiefly from the point of view of indiscriminate construction of heavy-duty roads where planning might distinguish among uses and limit express or heavy traffic to specially constructed lines. Certainly a great saving in cost could be made by such planning.

The next steps in road development would seem to lie primarily in—

(*a*) Classification and development of roads for specialized uses—as heavy-duty highways without grade intersections, freeways, parkways, provisions for pedestrians, bicyclists, and horseback riders, etc.

(*b*) Improvement of alignment, grades, and roadsides on greatly widened rights of way for existing roads.

(*c*) Development of rural roads, and

(*d*) Abolition of grade crossings with railroads, and, where traffic demands, with intersecting highways.

Each of these four aspects of road work will absorb huge sums of money during coming years and long range plans carefully related to other methods of transportation, probable population trends and industrial development must be prepared in advance to avoid wasteful mistakes. We cannot afford many examples like the million dollar bridge in Tennessee which was located below the flood line of a proposed reservoir.

For new special-purpose roads we already have a number of examples of both expensive and inexpensive methods of procedure. Presumably, for instance, it is no longer necessary to argue the desirability of by-passing through traffic around congested centers and towns instead of forcing through them at great expense of time or money. With the successful parkway developments in Westchester, N. Y., the lake front of Chicago, and the Mount Vernon Parkway at the Nation's Capital, the value of that type of pleasure-way has been demonstrated. The new "freeway" between Norris and Knoxville in the Tennessee Valley provides another example.

Much also needs to be done to make our existing highways more useful, efficient and pleasureable. Perhaps the chief need is wider rights of way to permit expansion, better curvature and grades, or roadside improvements. It is estimated in the land report that recreational use forms at least 60 percent of the total use of automobiles, a showing which would seem to justify more attention to the control and preservation of roadside appearance.

In the third field suggested—further hard surfacing of rural roads—it is difficult to estimate how far such a program should go. Many rural roads would be vacated under a program for the retirement of submarginal lands, and the traffic on others would not warrant expenditures for all-weather service. If 20 percent of the unpaved rural roads are eliminated, by this reasoning there still remain over 1,750,000 miles of unimproved third-class country roads to be considered. A rough estimate of $2,000 per mile produces the total of 3½ billions of dollars.

Finally, in the matter of grade crossings another huge outlay of funds seems probable, particularly if high-speed, light railroad trains are to become common. The American Engineering Council in a report dated April 7, 1933, suggests the early elimination of 5,000 selected railroad grade crossings at an estimated cost of $500,000,000. It has been variously estimated that further eliminations to the amount of 12 billion dollars would be justified. The prospect of such expenditures justifies forethought and planning to concentrate attention on the most needed cases of grade separation and to avoid any construction where rearrangement of roads or rails for other causes may make a saving possible.

Many rearrangements of transportation facilities might result from consideration of the effective use of all methods of moving goods and people, instead of compartmental planning of one method at a time. For instance, the very extensive highway development in the country has already made it clear that much of the railway branch line mileage is unnecessary, and the towns on railway branch lines can be better and more cheaply served by the highways. This fact, indeed, is one reason why the railways are now suffering so seriously. A partial solution seems to be to convert some of these railway branch lines into motor highways by paying the railways a fair price for these branch-line rights-of-way and substituting for the little-used railway a good highway. This should accomplish a dual purpose, (1) permitting the railways to abandon unprofitable lines and amortizing so much railway capital, and (2) supplying a right-of-way or highway at moderate cost which will be not only very direct, but frequently on a better location as to gradients and curvature than the ordinary

highway. In our great cities a better coordination of terminals farther out from the center of city would release large areas and values for more efficient uses.

Railroad reconstruction and modernization is now a public work within the terms of the act establishing the present Public Works Administration, and again seems likely to require large sums in the near future.

Not only rail and highway, but also waterway planning must be coordinated. Estimates for river projects based on studies by the Corps of Engineers run as high as $8,000,000,000.[1] Before any such program is undertaken, coordinated transportation plans should be worked out. Too often in the past expensive construction of waterways has been advocated and approved not with anticipation of their actual use, but primarily as a method of controlling transportation rates. That method of railroad rate regulation is extravagant and wasteful of public funds when administrative action can be substituted.

This brief review of some of the principal transportation agencies in relation to public works illustrates how considerations dealing with one project for one method of transportation inevitably lead to questions concerning all methods of moving goods and people and thence to other matters of human concern. Planning to get the full benefit from our expenditures on a given project must in turn depend on larger planning of related factors.

Housing Situation

A second sample of public works is housing, only recently undertaken as a public responsibility. Already a variety of housing activities have sprung up with different governmental agencies working on them and with some resultant confusion in the minds of the public. These governmental agencies are Federal, State, and municipal. In addition there are private agencies, a few of them like the Housing Associations of Pittsburgh, Boston, Philadelphia, Cincinnati and the Washington Committee on Housing, devoted exclusively to the subject of housing; many of them, like chambers of commerce or labor organizations, express their interest through committees. There are also several national agencies of private or semi-public character whose purpose is largely to stimulate citizen interest or to disseminate information

Among the Federal agencies that have been set up, there are:

1. *Federal Housing Administration,* which is concerned with the stimulation of private capital to enter construction enterprises.

> The central aim is to make home financing, on reasonable terms to the borrower, immediately and permanently safe and attractive for private capital
>
> The act does not provide any new machinery for direct loans to individuals by any Federal agency. On the contrary, it is designed to enable banks, building and loan associations, and other private-lending institutions to carry the load.

In addition to the above, title II authorizes the complete insurance of a mortgage covering a low-cost housing project, the principal amount which must bear a relationship to the appraised value of the project satisfactory to the Administrator and it may not exceed 10 million dollars on a single project.

2. *Public Works Administration—Housing Division,* which has a social program involving construction along lines in which private capital has not been effectively interested.

> It is the financing low-cost, low-rental urban housing in connection with the elimination of slums or "blighted areas", replacement being on the site or elsewhere as may be most advantageous in each case, and in special cases of acute housing shortages. It is not financing speculative or investment building projects.

3. *Home Owners' Loan Corporation*: The purpose of this Corporation is "to extend relief to home owners who are in immediate danger of losing their homes through foreclosure (the chief field of endeavor), although they have no mortgage on their properties, find it impossible to obtain, elsewhere, money with which to pay taxes and other encumbrances, and to provide for the necessary maintenance and repair of their homes. It also assists those who have recently lost their homes to recover them."

4. *Division of Subsistence Homesteads:* This organization "has adopted the policy of establishing homestead communities. It does not make loans to individual families. * * * In general, three major types of projects are being established:

> (*a*) Near small already decentralized industrial cities and towns, workers' garden homesteads are established within easy reach of the town where industries or other sources of employment are located.
>
> (*b*) In the vicinity of large industrial centers, workers' garden homesteads are established adjacent to industrial suburbs, thus encouraging a decentralization within specific urban areas.
>
> (*c*) Subsistence homesteads are established to demonstrate a means of rehabilitating stranded industrial populations such as those of the abandoned Appalachian coal fields.

5. *Federal Emergency Relief Administration,* which was established for general relief work, is now experimenting with self-supporting community developments constructed by workers on relief for their own use. This seems to be going in the field of subsistence homesteads, with the exception that the F. E. R. A. deals with a no-income group.

6. *Surveys of the problems:* Three important surveys have been undertaken and are nearing completion which will furnish important data:

[1] Letter of Secretary of War. House Doc. No. 395, 73d Cong., 2d sess. page 12.

(1) The Rural Housing Survey by the Department of Agriculture;

(2) The Real Property Inventory covering 64 cities, by the Department of Commerce; and

(3) The Financial Survey of Urban Housing, also by the Department of Commerce.

7. *The Alley Dwelling Authority of the District of Columbia,* as the name implies, operates only in the District of Columbia. "Within its means it has a pretty broad authority to experiment either on slum clearance or slum rehabilitation. Its importance is chiefly on account of location at the Nation's Capital and the fact that it may by nature of its experiments furnish valuable examples."

In nine States, housing authorities have been established by similar authorization of law and will operate in those cities to furnish valuable examples of what can be accomplished.

The above catalog of the organizations now in the housing field indicates the importance of the coordination of effort looking to a better understanding of the methods and scope of each endeavor.

Administration and Needed Legislation

The success of the housing program depends upon preventive as well as corrective measures. It is only partially effective to provide new housing of any standard if no steps are taken to eliminate existing substandard housing and to prevent the recurrence of existing conditions.

In most of our cities we have building and sanitary codes governing the construction of new housing but legislation or enforcement of legislation is lacking to govern cases of dilapidation, deterioration, and insanitation far below the standard requirements for new structures.

Many States have laws to protect the public against tubercular cattle as well as laws to insure a pure milk or water supply. Such laws require a definite standard of housing for cattle to protect the public, but laws to enforce corresponding standards for human housing are often not as definite or as vigorously enforced.

The successive steps necessary for the accomplishment of the desired results appear to be as follows:

1. Agreement of authorities on what constitutes substandard housing according to regional or sectional divisions, differentiating between rural and urban.

2. Public realization of the physical, moral, and economic liabilities represented by substandard housing.

3. The reflection of this realization in judicial decisions.

4. Enforcement of existing laws relating to the destruction of obsolete and dangerous buildings.

5. Enactment of further needed legislation.

The possibility might well be considered of requiring municipalities and States to adopt corrective and preventive measures as part of a general program to the granting of Federal funds for housing projects.

The intelligent administration of housing projects must obviously include efficient operating management. Special training for prospective managers must be provided immediately covering not only normal real estate training but also home economics, social case work, and similar courses leading to socially minded nonpolitical management.

Citizen Support of Housing Movement

Slum reconstruction and the provision of low-cost housing occupy a very definite part of the recovery program. The movement originated in private groups long interested and active in the improvement of housing and on the continued interest and support of these private groups the maximum development of the movement depends.

Water Projects

Since water projects are so fully treated elsewhere in this report, it is only necessary here to point out the importance of—

(1) Water supply and sewerage treatment projects now handled as non-Federal projects on a loan and grant basis. Over $550,000,000 of applications for such projects are pending before the Public Works Administration.

(2) Flood control, irrigation, and drainage proposals that mount to huge though indefinite figures.

(3) Power projects on a Federal or cooperative basis.

Rural Electrification

The report of the Mississippi Valley Committee points out that—

> of the 6 million farms in the United States over 800,000 are "electrified." but only about 650,000 have "high-line" service. The balance have individual plants, expensive to operate and limited as to use. Over 5 million farms are entirely without electric service. Estimates as to the number of these which can now economically be given service range from 1 to 3 million. * * *
>
> Several reasons might be advanced to explain why only 10 percent of the Nation's farms (less than 6 percent in the Mississippi Valley) purchase electricity. These are the lack of interest by operating companies in rural electrification, high cost of line construction because of the unnecessarily expensive type of line used, onerous restrictions covering rural line extensions, and high rates. * * *
>
> In cases where it is practicable, public transmission lines utilizing either Government or private power sources could be erected. Rural distribution lines will cost from $500 to $800 per mile to construct, and to amortize this cost in 20 years involves a cost to each of three consumers on a mile of line of about $1.00 per month.

Other Types of Public Works

These samples should not, of course, be taken as either an exclusive or as a preferred list of types of projects—but they do illustrate the need for planning. A list of all types of worth-while public works, such as recreation facilities, public buildings, soil erosion control, etc., would take pages if it were complete and would only serve to emphasize the complexity of the problem of criteria.

Future Volume of Public Works

Estimates of the total volume of worthwhile projects can be made on one or another of a number of general assumptions, such as—

1. Projection of the past rate of public works construction into the future.
2. Measuring construction requirements by demonstrable deficiencies as indicated by comprehensive plans and as measured by established standards.
3. Giving play to the imagination, with a reasonable anchorage to judgment, in possibilities of extension and expansion of public works and public service without restriction by tradition.

Based solely upon extension into the future of the average annual capital outlay for the entire United States (National, State, and municipal) of about $2,400,000,000 for the 10 years 1921 to 1930, the total of capital outlays for the 10-year period 1935 to 1944 may be estimated as approximately $24,000,000,000. Of course, such an extension of a past average makes no allowance or the factor of growth which has been so notable in past American expenditures upon public works and which presumably should and will continue in the future. Hence the 10-year total suggested may be regarded as a minimum estimate.

By adjusting past rates of capital outlay for individual classes of public works according to readily available evidence as to relative need and with a degree of optimism as to possible correction of the more glaring deficiencies in service, we reach an estimate for the 10-year period, 1935–44, of approximately $26,000,000,000. This estimate, like the preceding one, makes no allowance for growth.

Extension of public works into new fields and expansion of all public works, old and new, into the field of reasonable possibility from point of view of needful public service brings the estimate of magnitude of all public works over a period of perhaps 20 to 30 years to about 105 billion dollars or about 3½ to 5 billion dollars a year. Such an expanded program of public works would amazingly improve the public services and living standards of this country; but viewed in the light of traditional expenditures for public works the cost seems a heavy charge upon the national income. Whether 5 billions a year for roads, parks, sewers, public libraries, forests, waterways, good housing and countless such other facilities is more than we should spend is a problem which we shall have to solve in the light of future developments touching the aggregate national income, public finances, modes of combating unemployment, popular demands for pleasures and protections afforded by public works, etc.

SECTION II

III. PUBLIC WORKS AND "ECONOMIC STABILIZATION"

For a generation or more the possibility of using the construction of public works as a "balance wheel" to counteract the cyclical oscillations of business activity has been discussed by economists in foreign countries and the United States. One of the chief aims of those who sponsored the Federal Employment Stabilization Board in 1931 was to take a step toward "ironing out the business cycle." By advance planning of public works on a 6-year basis, they hoped that the Government might reduce the volume of contracts let in times of active business, thus accumulate a huge reserve of deferred projects, and so be ready to enlarge the scale of operations when unemployment became severe. The creation of the Federal Emergency Administration of Public Works in 1933 with a budget of $3,300,000,000 was an attempt both to relieve distress and to promote business revival by providing employment and stimulating the demand for products of the heavy industries.

In view of the importance attributed by many men to the use of public works as a stabilizing device, the National Planning Board gave the proposals of this nature close attention. To lay a firm factual basis for study, it asked Dr. Arthur D. Gayer to compile the best available data concerning the volume of public works constructed in recent years by American governments—Federal, State, and local. It also asked Prof. John Maurice Clark to analyze the economic results of various public-works programs, actual and proposed. What follows is based in part upon the findings of these investigators.

According to the estimates of the Federal Employment Stabilization Board, the total volume of all construction work done by American governments reached a peak in 1927 or 1928. In both years the dollar volume of all new construction was a little more than 3 billion dollars. After a slight decline in 1929, the volume of public construction rose to a new record in 1930—$3,300,000,000. This rise was due in large part to the efforts of the Administration to master the depression in its early stage.[1]

Three billion dollars is a large sum. But in weighing the importance of any item in the country's business, we face a problem in relativity. At the prosperity peak of the 1920's, private construction as estimated by different experts using different materials and methods attained a level of 10 or perhaps 12 billions. In no year of the boom period did public construction make a third of the total for all construction work. A quarter of this total is a fair fraction to keep in mind.[2]

[1] The shifting relations between private, public-utility, and Government construction in recent years are shown by the following estimates compiled by the Federal Employment Stabilization Board. It will be seen that the substantial increase of Government construction in 1930 failed to offset the decline of private construction. The catastrophic fall in the grand totals continued to 1933. Other estimates of the total volume of construction are given in the next footnote.

Estimated total volume of construction, by years, 1925–33

[Millions of dollars]

	1925	1926	1927	1928	1929	1930	1931	1932	[a]1933
Private	$5,237	$5,365	$5,175	$5,416	$4,451	$2,746	$1,761	$667	$575
Public utilities	2,851	2,935	2,933	2,900	3,265	3,204	[b]2,200	[b]1,332	[b]902
Government:									
Cities	1,283	1,302	1,482	1,422	1,339	1,495	1,302	797	400
Counties	788	676	885	829	556	709	329	137	600
States	411	404	438	502	576	706	786	551	300
Federal	245	230	240	270	305	390	510	580	500
Total Government	2,717	2,612	3,045	3,023	2,776	3,300	2,927	2,065	1,300
Grand total	10,805	10,912	11,153	11,353	10,492	9,250	6,888	4,064	2,777

[a] Preliminary figures.

[b] Data for construction by pipe line, gas, telegraph, and water works companies first became available in 1930. The inclusion of this item would raise the estimates for the last 4 years to the following levels:

	1930	1931	1932	1933
Public utilities	4,062	2,988	1,629	989
Grand total	10,108	7,586	4,361	2,864

[2] The total volume of construction work done in the United States is not definitely known. The first Federal census of construction was taken in 1930; but it covered only work done by contractors, and omitted the large volume of work done by business enterprises, farmers, and others on their own account.

The leading estimates which aim to cover the whole field are as follows for recent years:

Estimates of the total volume of construction work in the United States: By years, 1927–33

[Billions of dollars]

Source of estimate	1927	1928	1929	1930	1931	1932	1933
Federal Employment Stabilization Board, Corrington Gill	11.1	11.3	10.5	10.1	7.6	4.4	2.9
National Planning Board, Arthur D. Gayer	12.9	13.0	12.3	10.2	7.6	4.1	.....
National Bureau of Economic Research, Simon Kuznets	14.9	15.9	14.4	11.9	8.9	5.5	.....

The basic figures used by Drs. Gill and Gayer are the reports by the F. W. Dodge Co. upon the volume of construction contracts let in 27 States, supplemented by estimates for the States not covered by the Dodge service, actual expenditure reported by various agencies, and estimates for construction work done without the letting of contracts. Dr. Kuznets' estimate is based primarily upon the cost of the construc-

As the next step toward getting a just impression of the role played by public works, we should set the totals for the construction industry besides those for other great branches of the country's business. A few figures may be cited for this purpose. Start with the 12 to 14 billions of construction work done by governmental and private agencies combined in 1929. According to the census, the value of farm products in that year was 12 billion dollars; the value of manufactured products reported was 70 billions; retail sales of merchandise reached 53 billions. In that same year, the aggregate money income received by the people of this country is estimated at 81 billions. [3]

Of course, dollar figures for the output of single branches of business hide a deal of double counting. As a corrective we might subtract the cost of merchandise bought from retail sales, cost of raw materials from the value of manufactured products, cost of seed, fertilizers, etc., from the value of farm produce, and so on. But to be consistent, we should have to subtract cost of materials used from the value of construction work, which would take off more than 40 percent of our 12 to 14 billions.

Another approach to this problem in relativity is to consider, not dollar value of output, but number of men employed. On that basis it seems that in 1929 about 3 million men were employed in construction work, the maintenance of roads, etc.; 4½ million were employed in transportation, 8 million in trade, 9 million in the service industries, 10½ million in farming, and 11 million in manufacturing.[4] Altogether about 49 million persons claimed gainful occupations in the census of 1930. Thus the construction workers made about one-sixteenth of this total, and, if a quarter of all construction workers were employed on public works, they made about one sixty-fourth of the whole number of gainfully occupied. Again one may argue that the men making building materials should be added to the builders and maintenance workers; applying the 2:1 ratio, which is probably a gross exaggeration, we should have three sixty-fourths.

The basic fact revealed by these figures is that the construction of public works formed a minor fraction of a minor fraction of American industry even at the crest of the recent building boom—one of the greatest in our history. Federal construction work made only 11 percent of all public construction in 1929, and only 3 percent of total construction, public and private.

Advocates of the long-range planning of public works as a device for stablizing employment recognize that the factor with which they operate is not of the first magnitude. Their case rests upon two propositions: (1) construction work exercises an influence upon business cycles much greater than its relative volume suggests; (2) by wise planning and resolute administration public works might be made a much more potent factor in general business activity than it has been in the past. Both of these propositions call for analysis.

The strategic position of public works in business cycles arises from the fact that the cyclical swings in new construction have notably large amplitudes. That fact is demonstrated by statistics of building permits issued in American cities, of construction contracts let in cities and country districts alike, of ship building, and of additions to railroad mileage. Numerous records of experience covering a generation, supplemented by a few records covering several generations, show that the percentage of rise during the expansion phase of business cycles and the percentage of fall during the subsequent contraction phase are several times as great in construction work as they are in the production of perishable consumers' goods. However, construction work is by no means the only type of industry characterized by violent cyclical swings. Amplitudes as great or greater are found in the production of industrial equipment, such as machinery and railroad rolling stock, as well as in certain financial activities, such as the issue of new securities and transactions on stock exchanges. It is notable, also, that the production of quasi-durable goods for consumers is subject to cyclical swings almost as violent as those of construction and machine building. For example, the cycles in the output of passenger automobiles have amplitudes nearly as large as have the cycles in the output of automobile trucks.

tion materials produced to their users, the ratios of the cost of materials to the value of the completed structures, and a "construction cost index." Dr. Kuznets' method should catch the very large number of small construction jobs which escape any reporting service. (See bulletin of the National Bureau of Economic Research, no. 51, November 1934.)

Of the total volume of construction work done in 1927–29, almost one-half is credited to individuals and private businesses, about one quarter to public utilities, and about a quarter to governments, Federal, State, and local. By 1932, public construction had become half of the total; in 1933 it exceeded that proportion. Of course this relative gain was due primarily to the catastrophic decline of private and public-utility construction.

The break-down of public construction by type of government undertaking the work is given as follows by the Federal Employment Stabilization Board:

	Average percentages, 1925–29	Percentage in 1933
City governments	18	31
County governments	26	8
State governments	47	23
Federal Government	9	38
	100	100

[3] *National Income, 1929–32.* S. Doc. No. 124, 73d Cong., 2d sess., Washington, 1934, p. 10. The national income produced in 1929, which includes business savings, is estimated at 83 billions.

[4] See the estimates for 1929 based upon the Census of Occupations taken in April, 1930, given in *America's Capacity to Produce*, by Edwin G. Nourse and Associates, Washington, Brookings Institution, 1934, p. 544.

In any attempt to stabilize business, it seems wise to concentrate effort upon those branches of industry in which the phenomena of boom and depression are most accentuated. Where the percentages of unemployment among the workers attached to industry run highest in bad years, there is the most need of relief; where the current rate of activity falls furtherest below the average level of performance, the largest gains can be made if a revival is effected. Viewed from this angle, the construction industry appears to offer as favorable a line of attack upon business depression as any other. That it has been preferred by government planners to other industries which suffer prostration equal to that of the building trades is due to the fact that government needs roads, sewers, water reservoirs, public buildings, and the like on a vastly greater scale than it needs other durable goods.

So far as effectiveness in promoting a revival is concerned a program of equipment-buying by railroads, factories and mines would serve as well as the stimulation of public works. At the outset of the recent depression, President Hoover sought to combine both lines of attack by persuading business corporations, notably the railroads, to buy and build freely, while he also encouraged public construction. As shown by the footnote on page —, the statistical record reveals an increase of public construction in 1930, a trifling decline in public-utility construction, but a heavy falling off in private construction. The latter change much more than offset the gain in public works. In 1931 both public-utility and private construction fell heavily and public works slightly. In 1932 there was a further large decline, this time in all three categories.

The hope of increasing greatly the potency of public works as a stabilizing agent rests upon "long-range advance planning." If a large proportion of all the public works put under contract in the latest period of business activity could have been deferred without serious detriment to the general welfare, then there might have been accumulated a huge "reserve" of projects to be executed in the years of depression. To illustrate by a hypothetical example which has a statistical excuse, if not a statistical basis: Say that the total volume of all construction work in the United States averaged 12 billion dollars per annum in the 6-year period 1925–30; say also that public works made a quarter of this total; further, say that it is feasible to defer the execution of one-half of the public works for a period not exceeding 6 years. Suppose, finally, that this policy had been rigorously followed by all American Governments throughout our period, despite the mild depression of 1927 and the considerable unemployment of 1930. Then the "reserve" of public works available for letting in 1931 would have amounted to 9 billion dollars. In other words, the "reserve" of public works accumulated over a 6-year period would have equalled the private construction of a single average year.

How gravely this hypothetical example misrepresents the possibilities, we do not know. Not until a genuine experiment is made in long-range planning by a representative group of municipalities, counties, and States, as well as by the Federal Government, shall we have a secure basis for saying whether less than half or more than half of public works can be shifted about in time. The shifting need not be limited to deferring projects that can wait without causing grave inconvenience; it may include also accelerating projects that will soon be called for. What can be shifted in one of these ways without serious detriment to the public interest is a matter of judgment, and guessing at what public authorities in different jurisdictions would decide is an unprofitable exercise. How long the postponement is endurable and how much anticipation is prudent are further questions upon which opinions will differ.[5] And if the authorities agreed that they could effect postponements when business was active, would they do so? Attractive plans presented to the public by persuasive projectors, when spirits are buoyant and financing is easy, might seduce aldermen, State legislators, Congressmen, and planning boards from the straight and narrow paths marked out by their programs. At times, the return of severe depression seems so remote and so unlikely that present renunciation appears a counsel of perfection. How closely American Governments would adhere to their own plans we can only guess.

Nor are the purely technical difficulties of making long-range plans for public works readily disposed of. The task of preparing a large "reserve" of public works in such form that they could be put under contract promptly in an emergency involves much work. First the postponable projects must be segregated from the projects that brook no substantial delay. Second, the locations of the postponable projects must be decided, and the often complicated problems of obtaining legal titles to the land required must be solved by purchase, condemnation, or some other procedure. Third, the engineering and architectural plans for the various projects must be prepared. To make prompt action possible, these plans should be carried to the stage of preparing specifications ready for submitting to bidders. Fourth, the methods of financing must be worked out. Since tax collections are likely to fall off just when it is desired to expand public works, and since Government

[5] The most detailed American study of the problem is *The Stabilization of Employment in Philadelphia*, by W. N. Loucks, Philadelphia, 1933, p. 181 and following. Mr. Loucks' judgment is that about 50 percent of the improvements financed by loan funds in Philadelphia from 1919 to 1928 could have been considered shiftable from one year to another. Had the city's public works been handled in this fashion, he estimates that 10 to 15 percent of the unemployed could have been given work If other governmental units also had adopted the policy of long-range planning, a larger proportion of the unemployed could have been aided.

credit may suffer in consequence, the surest course is to accumulate special funds which are held in reserve until the time for release arrives.

All this sounds formidable enough, but it is not the full list of technical difficulties. The rates at which and the directions in which American communities grow keep changing. What seems an excellent project in 1 year may seem a poor choice a few years later. The kind of facilities desired by the public is also subject to rapid change. Early in our career as a Nation we spent sums enormous for those days upon canals that were presently superseded by railroads. Later the railroad net was expanded with Government aid to an extent which forced retrenchment when the automobile truck became an important factor in transportation. Perhaps many of the roads we are building today will be abandoned in favor of better locations for the high-speed trunk roads of the future. Even more rapid are the changes in methods of construction and in the materials used. Thus, to be thoroughly satisfactory a "reserve" of public works would have to be revised at intervals, in the same way that a city plan should be kept up-to-date. This means that sometimes old projects would be abandoned, that more often new projects would be introduced, and that more often still the legal, architectural, engineering, and financial plans for given projects would be worked over again. The overhead charges of doing a really good job on long-range advance planning of public works would be considerable.

A further technical problem of no slight moment concerns the management of the reserve funds. Suppose that this country gradually accumulated an aggregate fund of 9 billion dollars to be used for public works in the next period of grave unemployment. How should this fund be carried until it was used? If it were put into bonds, could these bonds be sold without heavy loss when the time for disbursement arrived? If the money were deposited with commercial banks, could they meet the calls upon them without grave embarrassment? Would savings banks be better depositories? Or could some plan of financing through the Federal Reserve System be worked out that would provide means for paying the bills and not threaten a serious "inflation"? These questions involve issues too technical for discussion in this place; but it is clear that satisfactory answers would have to be found before the program of long-range planning could be perfected.

A final set of difficulties concerns the determination of the times at which public construction shall be greatly expanded. What authorities shall make these decisions? Shall local governments be encouraged to decide on the basis of local conditions? Shall an effort be made to induce local and State governments to act in concert, under the leadership of the Federal Government? On what principles shall the authorities base their decisions? Is the consensus of business opinion as to current conditions and future prospects, interpreted by some Government agency, a sufficiently definite guide? Or would some set of statistical indexes be safer to trust? If so, what choice shall be made among existing compilations; or what additions must be made to our present battery of figures? Should attempts be made to counteract mild contractions in business activity, like that which began in 1926 and ended in 1927? Or is it wise to husband the public-works reserve for use in serious depressions like those which followed the recessions of 1873, 1893, 1907, 1920, and 1929? If the latter policy is followed, should the aim be to increase public works when the gravity of the business difficulties is revealed? Or should the aim be to let the process of financial liquidation proceed for a considerable time, and use large public construction as a means of stimulating a revival when the situation is ripe for an upturn? Or is there some stage intermediate between the recession and the trough of depression that is the best moment to act? Before governments let large contracts, should they insist upon substantial concessions from the business interests benefited in the form of low prices of materials and modest profits for contractors? Should they also review the rates of wages prevailing in the building trades and require downward adjustments in certain cases? If so, what criterion could they apply to determine what wage rates were too high? Once again, we should need ample space to discuss these problems with the thoroughness which alone would justify definite answers to our questions. But we can scarcely overstress the importance of these questions to the policy of long-range planning.

We have set forth faithfully the difficulties which we foresee in an effort to use public construction as an economic balance wheel. Nevertheless, we recommend that such an effort be considered with care by some properly constituted agency of the Federal Government. For we believe that the technical difficulties can be gradually mastered in large measure by energetic work, and we believe that the social gains resulting from this step toward reducing the severity of cyclical depressions might be substantial. It is chimerical to hope that long-range planning of public works would suffice by itself to "iron out the business cycle"; but such planning is a promising line of effort to include in a program looking toward stabilization.

Given the will to achieve, it should not be impossible for Federal, State, regional, and municipal officials to decide what public works should be executed promptly and what can be postponed, until unemployment has become grave. Nor are the problems of anticipating future needs insoluble. State and local governments

might learn to work in unison under Federal leadership. The legal, engineering, and architectural plans have to be made sometime; it is not impossible to make them in advance, and the cost of revising plans from time to time, though appreciable, is less than the cost of reconstructing works actually built on plans that later prove to have been unsatisfactory. Advance plans for financing are hard to make, but any task that forced the financial departments of American governments to look ahead more definitely might have incidental advantages of value. Among the gains is the reduced cost at which construction contracts may be let in years of depression. Given efficient management, these savings might exceed the overhead costs of the whole planning service. Nor is the problem of carrying and later disbursing reserve funds accumulated in good times an insoluble one; indeed, it is possible that this process might be so managed as to check the excesses of booms in some measure. As for the problem of timing the release of public works on a large scale, we think that an objective, quasi-automatic guide might be developed through improvement in our statistics of employment. Even in their present imperfect state, American indexes of employment give on the whole a more faithful picture of business cycles than any other single set of figures, and of course, cyclical unemployment is the ill which the long-range planning of public works seeks most specifically to combat. When a widely representative index of employment showed a percentage decline of a magnitude to be fixed in advance by careful study of past experience and analysis of the new figures, the Federal agency charged with responsibility might advise the President that the time had come to accelerate public construction. Presumably this percentage decline would allow for a substantial reaction from the peak of the preceding expansion, but not for such a cataclysmic fall as culminated in 1932 or the early months of 1933. A considerable degree of synchronizing the policies of the central and local governments would render the policy more effective; but there should be ample opportunity for local departures from the national program in regions where grave emergencies occurred.

How much might be gained by a skillful development of advance planning along some such lines as those sketched here is the critical question. There are two reasons for rating the possible gains higher than is suggested by the rank of public construction among the country's industries. One is the prospect that the fraction of the national income spent upon public works will continue to grow in the future as it has grown in the past. Not only shall we demand more and better recreational facilities, highways, hospitals and so on; but also our working definition of what constitutes a public work will continue to expand. The second reason for expecting substantial gains is supplied by what are commonly called the "secondary effects" of construction works.

The first effects of expending a dollar upon a job will be to pay, say 50 cents for labor (including the services of the contractor), and 50 cents for materials. The secondary effects depend upon what the workers, contractors, and dealers in materials do with their money, and upon what those to whom they pay it do. If the expansion of public contracts is not undertaken until business has receded substantially from its preceding peak, it is probable that the wage earner, the contractor, and the maker of materials all will have urgent need to spend their money promptly. (1) So far as they buy more food, clothing, etc., for their families than they would otherwise have obtained (but only insofar), they expand the retail demand for consumers' goods. If the stocks of these goods have been reduced as far as dealers deem wise, the increased purchases will call for increased production, increased employment, and increased wage disbursements. If the stocks of consumers' goods are still larger than merchants, warehousemen and manufacturers like to carry in view of the slack trade, the increased demand will at least bring nearer the day when the stocks will be reduced to a level calling for fresh production. The secondary increase of employment produced by the public works dollar is deferred; but meanwhile the merchant has a little more money which he can use in one of the ways we are tracing. (2) Not all of the public works disbursements will be spent by the first recipients for consumers' goods. Many of the wage earners, contractors, makers of materials, and retailers who get an early slice of the dollar, owe money. They use part of their receipts, not to increase consumption, but to reduce debt. This line of secondary effects need not increase employment, though probably some of the money going to creditors will pass on to retail dealers whose stocks are low enough to call for replenishments. But there is a gain from the reduction of debt in a period of depression. One of the prerequisites for revival of business is that the tangle of crisscrossing indebtedness left by the preceding period of hyperactivity be straightened out, and public works disbursements should make a modest contribution toward this desideratum.

A different line of secondary effects must be noted as possible. If the money used to finance an expansion of public works is drawn by taxation or borrowing from that had been destined by their owners to prompt investment in buildings and industrial equipment, then the total volume of construction work is not increased by governmental intervention. A business revival may be retarded rather than accelerated, under such circumstances by an increase of public and a shrinkage

of private works. That effect is not likely to occur, however, if the expansion of public works is begun at a time when individuals and business enterprises fear to invest and if the governmental expenditures are reduced as private initiative expands. Even so, it is possible that the Government may have used funds that would have gone into private investment during an early state of the revival. To guard against this contingency requires careful financial management, into the details of which we cannot enter here.

Another possibility is that an expansion of public works will retard revival of private enterprise by checking the reduction of construction costs before it has gone far enough to encourage the letting of contracts for houses, apartments, office buildings, factories, etc. This effect may be guarded against, as suggested above, by requiring concessions in costs that the depressed construction industry would be ready to make, if assured of a considerable increase in work. But to decide just how far prices and wages should be reduced would be a difficult problem.

We have carried this analysis far enough to show that the secondary stimulus to employment given by outlays for public works in a period of business depression is intricate in character, dependent upon conditions that vary from trade to trade and hence is impossible to calculate in advance except in the roughest fashion. But there can be no doubt that the expenditure of public funds, if wisely planned, starts a series of processes favorable either to a cumulative growth of employment outside of the construction industry, or to the reduction of commodity stocks and the liquidation of outstanding debts. These processes may take some time to produce appreciable effects, but the lags are to be reckoned in months rather than in years. If an improvement in the business situation does not occur, it must be because other and more powerful factors are exercising an adverse influence. For example, if private construction expands, the unfavorable secondary influence of the shrinkage will more than offset the favorable secondary influences of the expansion. All that one can say under such circumstances is that the total situation will not become so grave as it would have become if both private and public construction had shrunk. To be tolerably sure of producing a net gain in employment and a real impetus to business revival, the public-works program in a country as large as the United States should be planned on a huge scale. As matters now stand, a public-works "reserve" of 10 billions of dollars would not exceed the decline in private construction during a major depression.

Provided that reserves of projects on some such scale can be accumulated in shape for the prompt letting of contracts, provided that operations are timed to begin after the liquidation of financial excesses has made considerable headway, and provided that the funds can be secured without checking private enterprise or overtaxing public credit, we believe that public works can be made a stabilizing device of value. But to accomplish this result would require systematic effort, consecutively maintained over good years and bad alike, by Federal, State, county, and municipal governments. Without advance planning of this resolute sort, past experience indicates that public works can at best mitigate in some measure the sufferings and losses of depressions.

SECTION II

IV. PLANNING STEPS FOR FEDERAL PUBLIC WORKS

Every public-works project goes through a series of stages or steps and at each stage new considerations and special problems are encountered. The long-range planning of public works is the summation of the decisions made at each of these steps, which for convenience of discussion can be set down as—

1. *Planning,* involving decisions on What to Plan—an initiatory function; and The Preparation of Plans—an administrative function.
2. *Programming of* projects—a budget of construction—a long-range program for approval by Congress.
3. *Appropriation.*—The selection or approval of projects for construction—a legislative function resulting in a lump-sum appropriation for expenditure on projects within an approved program.
4. *Negotiation* with State and regional authorities for the basis of Federal participation.
5. *Allocation* of funds among constructing agencies—local, State, regional, and Federal.
6. *Construction*—the execution of projects.
7. *Payment*—for projects.

Planning

The planning of public works should be considered as an activity of one section of a national planning agency, working through a committee or group representing the interests most concerned and developing cooperative relations with regional, State, county, and city planning boards.

What to Plan?— The choice of projects to be developed—planned—has been almost entirely left to the administrative agencies of Government, and largely to the construction or service bureaus. Proposals are developed from—

(1) The run-of-the-mill work of a bureau—as for the replacement of a lighthouse; or to meet the space requirements for a Washington office—as service items for continuation and effective conduct of the work.

(2) The expansion policies of special types of public works as outlined by legislation under the Federal-aid highway program or by custom in the cases of river and harbor development or of Federal buildings in scattered cities.

(3) The natural extension of other similar services performed by a given agency.

(4) The desire of bureaus and divisions engaged in large projects to hold together an efficient organization and, of course, most of all from—

(5) The desire of the citizens or special interest groups to secure projects for the development of their States or neighborhoods.

A measure of restraint upon the free exercise of discretion in these matters is exercised by—

(*a*) Limitations on appropriations available for preparation of projects.

(*b*) The budgetary prohibition against initiation of projects by Federal bureaus without approval from the Budget Bureau.

(*c*) The activities of a few bureau and departmental agencies, such as the Rivers and Harbors Board, for the sifting of projects, and by—

(*d*) The machinery of the "Authorizing Act."

No one is responsible for filling up the gaps and crevices between policies and projects. This seems to be the most serious deficiency in the present arrangements, although there are many opportunities for the better organization of "sifting" agencies within the departments to obviate duplication of effort or unwarranted work. Since it is important to maintain and encourage initiative and responsibility for meeting current needs within the separate bureaus, it would probably be unwise further to restrict their activities in initiating projects. There is need for—

1. Better informational service as to what proposals are under consideration in various bureaus, and for
2. An initiating and coordinating agency to check up and follow through the various aspects of such general public-works policies as may be approved by the Administration or requested by the Congress. From a well organized information service, the needed projects to fill up the gaps would soon be apparent and a suggestion to an appropriate agency would almost invariably produce cordial cooperation.

Initiation of general studies, such as those just completed by the Mississippi Valley Committee and the water resources section of this Board, would naturally fall within the field of the proposed national planning board. A series of such studies in new fields and reviewing the coordination of projects in old fields would constitute a continuing activity for that part of its staff assigned primarily to public works.

Preparation of Plans

The actual preparation of plans involves radically different problems according to—

(1) The variety of purposes to be served by the proposed project, or

(2) The degree of specialization in the engineering art to be applied, or

(3) The number of agencies necessarily concerned in the work.

Planning a "service" project, like the lighthouse previously cited, is obviously a job for the Lighthouse Service or some other specialized agency which knows the needs to be met and the specialized technique involved in the design—battleships, for instance, should be planned by the Navy. This simple rule will not carry very far, however, for in almost every case a variety of services or of purposes are to be served in a single project. It then becomes a problem of designing a project to serve many purposes in only one or two of which the designing agency is a specialist.

Where a number of Federal agencies or functions are concerned in a single project—as in a dam or transportation facility or a Federal building—the alternative procedures have been either:

(1) To build up a varied staff in one office including experts in the other related fields by direct employment of new men, or borrowing from other departments, or

(2) To work through coordinating committees which are invariably cumbersome and inefficient for this kind of work.

Neither method is entirely satisfactory, but no agreement has yet been possible toward establishing a single public works planning staff or to simplify the borrowing of technical services from a central pool or from individual agencies.

An even more difficult problem is encountered in coordinating the planning work of Federal agencies with State and local authorities. Evidences of the lack of such cooperation are too numerous to need the citing of specific cases. Thus Federal buildings are sometimes located in defiance of civic center plans of cities and towns, Federal approval of projects is sometimes used as a lever to force local approval even though contrary to well considered plans, and occasional failure of Federal officials to deal tactfully with local officials evidence lack of coordination. The trouble in such cases, paradoxically enough seems often to arise from too great emphasis on the separate fields of Federal and local government in some cases, or from misunderstanding of the division of responsibility in other cases. Some single authority must ordinarily be responsible for making plans for a given project.

The National Resources Board, as successor to the National Planning Board, is endeavoring to find a working arrangement for solving this type of problem in various combinations. Through the City Planning Commission of Cincinnati the public buildings problem is being studied; through the St. Louis Regional Planning Commission an analysis is being made of the interstate, metropolitan, and Federal interest in the Mississippi River at that point; and through the State planning boards, district chairmen, and regional planning commissions, interstate and Federal interests of great variety can be and are being planned. The Tennessee Valley Authority is an example of Federal planning of interstate projects, while the Pacific Northwest Regional Planning Commission provides a method for securing State responsibility in planning with provision for coordinating the actions of adjoining States and of Federal agencies through a Federal officer serving as chairman of the commission.

From the limited experience upon which we can base any recommendation, it now appears that State planning boards may prove sufficiently strong to handle intrastate projects and the coordination of the municipal and county governments involved in large-scale operations wholly within its borders.

For interstate or regional operations it seems much more clear that Federal leadership, at least in the making of plans, is essential to success. Continuation in some form of the consultant assistance now given to State and regional planning organizations may prove to be the most effective form of Federal cooperation in bringing together State planning agencies to form regional groups suitable for the administration of interstate public works projects.

Programing Planned Projects

The orderly programing of public works projects is the third step in planning public works. As in the case of the Budget in relation to financial affairs, it is or should be a responsibility upon the executive to present to the legislative branch a balanced construction program. Balance must be maintained among types of projects, among construction agencies, in the location of projects among the States, people, needs, etc. Programing involves the time element—the long-range timing of public works in relation to business cycles and a sequential relationship among the projects themselves. The Congress changed the Budget, and would doubtless change the program from time to time, but the existence of a carefully organized plan should assist the Congress as much as the executive departments.

Beginnings have been made toward the formulation of a balanced program of Federal public works, and corresponding movements have appeared in several States and cities. The Budget procedure provides one kind of program which was supplemented in the case of the Federal Government by the Federal Employment Stabilization Board. A particularly valuable contribution of this latter organization was the preparation of 6-year construction budgets by the bureaus and construction agencies instead of the prevailing single-year budget. The work of the stabilization office, however, has been very limited in scope and has left out of consideration many types of balance which are essential to a complete program.

In the preparation of the "Comprehensive program of public works" required by the Recovery Act, the lack of plans on which the program could be based

proved an insuperable obstacle to the Federal Emergency Administration of Public Works. The best that could be done in formulating criteria for the selection of projects was—

(1) A rough quota system for the geographic distribution of projects in relation to unemployment and population.
(2) A reasonable excellence of technical design.
(3) The bonding power of the governmental unit asking for a loan.

For the rest, decisions had to depend upon the judgment of a series of more or less well-informed individuals, since it was a rare exception rather than the rule when a large-scale and long-range plan was available to check the project.

One of the most disturbing elements in the Federal agencies doing construction work is the lack of a continuing program—expert staffs are constantly being assembled and dismissed. There is a special need for programming to keep expert organizations continuously busy on worthwhile projects, and this means selecting agencies and building organizations with a long-term program in view.

A valuable example of the possibilities for a program of public works in one large field was provided by the work of the President's Committee on Water Flow. This committee in the short space of 6 weeks collected current projects and proposals for development of our water resources. It acted through a series of coordinating committees representing all the agencies concerned, with the central secretarial service supplied by the National Planning Board. Perhaps the most important gain from this work was not the collecting of projects or the sifting of projects, which was originally considered the main function of the committee, but the broadening of the point of view of the participants in the many discussions within the technical subcommittees. The participants in the meetings of these committees found that there were many other angles than that of their particular specialty to be considered in judging of the value of water projects, and they soon saw that considerations controlling the choice of items in the water program were closely related to problems of land use, economics, and social significance.

A similar situation has been disclosed by the work of the Mississippi Valley Committee of the Public Works Administration, where the studies by the several experts composing the committee have inevitably led into problems of transportation, land use, population distribution, and numerous other lines of thought, all growing directly out of problems of navigation, pollution, water supply, and other factors which are normally considered as strictly water problems.

The procedure for preparing a program for a water project used for many years by the War Department offers another example of programming in relation to the selection of projects. The first step in a river or harbor improvement is authorization by Congress for a preliminary examination and survey. In effect, this authorizes the Chief of Engineers to direct the district engineer in whose district the proposed improvement lies to make a preliminary examination and to report to him whether there appears to be sufficient merit in the proposal to justify a thorough examination.

The district engineer's report passes via the division engineer to the Board of Engineers for Rivers and Harbors (of seven engineer officers) which reviews all river and harbor improvements from an engineering viewpoint. The board report, with those of the district and divisional engineers, is passed on to the Chief of Engineers who reports to Congress that a thorough examination and survey are justified or are not.

If the recommendation is favorable, Congress usually authorizes a survey and the Chief of Engineers directs the district engineer or such other officer as he may designate to make the survey and report. When completed this report is referred to the proper committee of Congress—that Committee on Rivers and Harbors in the House and the Committee on Commerce in the Senate. Upon passage of "an authorization to improve" bill through both Houses of Congress and signature by the President, the proposed improvement becomes an adopted project. The actual construction work begins on it when Congress provides the necessary funds.

Since 1914 it has been the custom to make appropriations in lump sums each year for rivers and harbors improvements which have been authorized by Congress, and the allotments from this lump-sum appropriation to the separate projects by the Secretary of War, upon the recommendation of the Chief of Engineers of the Army. If there are any projects in the pending authorization bill upon which work should not be carried on, the President or the Secretary of War is still in a position to order that no allotments shall be made for these projects.

A somewhat similar situation exists in the field of public buildings, where the Secretary of the Treasury and the Postmaster General are authorized by the Public Buildings Act of 1926 to report annually to Congress as to needed public buildings. They are responsible for the preparation of a "program" and money is appropriated largely on the basis of the estimates submitted by the Office of the Supervising Architect.

These examples illustrate the fact that in several fields the responsibility of the executive for the presentation of a program of public works is already recognized. The apparent need now is to expand the type of projects included in the program so as to cover all of the major fields of Government construction. A central public-works authority or administration might

be made responsible for the preparation of such a program for submission to the President, just as the Director of the Budget is responsible for presenting a fiscal program for his action, and for transmittal to Congress.

To provide for the proper relationship between work projects and employment or other considerations primarily in the field of other agencies, a coordinating group such as the present Board of Public Works seems to be needed, which, like other committees of this sort, could be served by the central secretariat of the proposed national planning board.

Appropriation—Selection or Approval of Projects

In the days before the Budget, Congress did all the selecting of public-works projects, acting under pressure from the various bureaus and departments most concerned. The activities of the bureaus have now been funneled through the Budget so that much of the jockeying for position among Government agencies has been stopped. Congress naturally retains the basic control of the finances of the Government.

During the last 2 years an experiment has been tried through delegation of authority to the President to formulate and construct a "comprehensive program of public works." The success of that experiment cannot be judged adequately as yet. It seems certain that many unnecessary or unwise projects have been rejected and equally certain that not all the approved projects have been as carefully related as advance planning would have made possible. This situation is the inevitable result of the necessary speed demanded by a grave emergency, lack of previous experience in such programs, and lack of plans upon which to base the program.

From the experience of the last few years with rivers and harbors, public buildings, public roads, and the Public Works Administration, it would seem to be entirely practicable for the Congress to approve or amend a general program submitted by the President covering a number of years, and then to make annual appropriations to be applied to the construction of projects within the program in the discretion of an Administrator of Public Works or the President.

A certain degree of flexibility in the allocation of funds to specific projects within an approved program is desirable, if not absolutely necessary. Only through such flexibility can we secure the full usefulness of the money to be spent and prevent tying up funds in incompleted projects or in excessive reserves held for undertakings the cost of which was overestimated. By leaving some discretion to the executive branch in the handling of specific construction jobs, the work of various construction agencies can be more effectively integrated and continuity of staff maintained. If Congress absolutely controls the program, it would be reasonable to place on the administration responsibility for the effective use of the money within the approved program. This method of procedure would also not encroach in any way upon the prerogatives of the Budget Bureau, but would provide the possibility of speeding up public works in time of depression because of the availability of planned projects awaiting only funds to begin actual construction.

Negotiation

Even if this method of securing a Federal program and flexibility within the program meets with approval and is adopted, a difficult problem will still remain in securing coordination with the States and local governmental units. In normal times their construction budgets are several times larger than that of the Federal Government.

The work of the Reconstruction Finance Corporation and the Public Works Administration provides a revolving fund for construction of public works in cooperation with State and local or even private agencies. There is need for new methods of selecting projects by a number of agencies at the same time when their several interests are involved. As shown in another chapter of this section, it seems likely that available funds from the Federal Government under appropriate conditions might facilitate cooperation with and among agencies of other jurisdictions.

Allocation

The actual construction of public works in which the Federal Government is directly concerned involves three types of agencies:

(1) The service or incidental construction branch of a bureau or department primarily interested in other aspects of administration.

(2) The direct construction bureaus building dams, roads, waterways, public buildings, etc., by contract or force account, and

(3) The supervisory or cooperating agencies, handling construction funds and projects in cooperation with State and local governments.

An approved program of public works, suitably revised annually but always looking many years ahead, would permit allocation of specific jobs to the agency in the best position to carry on the work. There is then a question as to the best organization of these constructing agencies within the Federal administrative machine.

It is generally agreed that the numerous "service" agencies within the larger departments and bureaus are essential to the work of these agencies and if cut out they will inevitably grow again. There is always danger lest they get overgrown and become dangerous in their effect upon the parent agency. That danger can, however, be controlled through the diet provided or not provided by the Budget.

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There have been recurrent proposals through the years for a consolidation of the principal construction bureaus into what might be called the "Construction Service." Such a service might combine the Office of the Supervising Architect, the construction activities of the Bureau of Public Roads, the river and harbor work of the Corps of Engineers, and the Reclamation Service. There are obvious advantages in a consolidation of these bureaus in pooling the expert services of the Army and civil engineers and in making use of the combined experience of these several offices.

It has been objected in the past that a combination of construction agencies would produce an unwieldy organization, stifle initiative and experimentation, and might seriously interfere with current work during the period of transition. If these objections are considered obstacles to setting up a single construction agency, some of the advantages of consolidation can be secured by less drastic measures, such as the organization of an engineering pool for joint use of expert services or more effective system for borrowing assistance from one or another agency. Perhaps the most important need is a pooling of funds and a central agency for allocation of work projects to different agencies in order to secure continuity in their activities.

For the construction of projects involving interstate or intercommunity relations, new agencies are needed backed by compacts or agreements for the appropriate division of responsibilities and costs. The New York Port Authority, the Colorado River compact, the arrangements on the Sacramento River, the Capper-Cramton Act for park developments around Washington, the Mississippi River Commission, and the Tennessee Valley Authority, present a variety of methods and agencies for cooperative action. "Improvement authorities" have been suggested to obviate the difficulties encountered in handling intercommunity projects and to consolidate some of the overlapping governmental jurisdictions that now so complicate the problem.

SECTION II

V. EXPERIENCE AND PROPOSALS—A PUBLIC WORKS ADMINISTRATION

In each of the planning steps outlined in the previous section the Federal Emergency Administration of Public Works has had a part during the last year. In the choice of what to plan, for instance, numerous decisions have been made through allocation of funds to Federal and non-Federal agencies in order to prepare specific projects, such as the sewage disposal plan for the District of Columbia, plans for the withdrawal of submarginal lands, or the long-range program for the great central valley prepared by the Mississippi Valley Committee.

By an announcement early in the history of the new Administration that complete plans for projects would not be necessary to secure allocation of funds, it was made evident that a statement of need might be sufficient to secure money in order to prepare plans, as well as to carry them out. The cost of engineering and architectural services has not always been included in the cost of the project, but the Public Works Administration has influenced the choice of projects to be studied and planned.

No direct planning of structures of work has been undertaken by the Public Works Administration itself, but, as already noted, through the National Planning Board and the Mississippi Valley Committee, many efforts have been made to coordinate proposals for varieties of projects and to find the appropriate interrelation among them. Some of the allocations to Federal bureaus have been used for preparation of plans in the usual manner current in the bureaus concerned.

Programming of projects has been the primary function of the Public Works Administration as set forth in the National Recovery Act.

The procedure followed has been summarized as follows:

> All projects requested by Federal agencies pass through the Projects Division in the Public Works Administration, with the exception of those involving construction of Federal buildings, such as post offices and similar structures. The Projects Division examines all projects from the standpoint of engineering, finance, and economics. In some types of work, notably river and harbor improvements, such examinations and studies have previously been made by the Corps of Engineers. In these cases, when the project has been recommended by the Corps of Engineers, no further examination along these lines is deemed necessary.
>
> Non-Federal projects, with the exception of transportation and housing loans, begin in the office of the State engineers (P. W. A.) and pass with its recommendations to the Projects Division at P. W. A. headquarters in Washington. They are then examined from financial, engineering, and legal points of view in the divisions bearing those titles. Transportation and housing projects do not go through the State offices, but begin at once in Washington where they are examined separately in special divisions devoted to those subjects. In case a project is rejected, review is possible by the technical board of review attached to the deputy administrator's office.

Continuation of Certain Functions of P. W. A.

The Federal Emergency Administration of Public Works ceases to exist on June 16, 1935, unless further provision is made by Congress for its continuance. After that date the President is authorized to transfer needed activities to other agencies. Whether or not the administration is continued, some of its activities *must* be carried on to complete what has already been started. Other activities, in modified form, *might* be utilized as the nuclei for a continuing organization for public works.

Among the activities which will not be completed by next July is now the work of the Inspection, Accounting, Administrative, Engineering, Legal, Finance, and Statistical Divisions. The Inspection Division will be needed because construction work will still be under way and must be watched as a protection for the bonds taken to pay for the project. Even after the work is done inspection of maintenance may have to be undertaken. Statistics must be kept up to date, and since construction work will be in process, the Accounting Division will still be busy, and, finally, as long as the Government holds the bonds of countless States counties, and municipalities, some parts of the Finance Division will be needed to keep track of the value of these holdings and of the effect on them of other actions by the issuing authorities.

The disposal of the bonds taken by the Public Works Administration might be turned over to the Treasury, because of the obvious relation of the sale of State or local government securities to the market for Federal bonds. It has also been suggested that the portfolio of municipal and State paper now hold by the Government might be the basis for a new service to govern-

mental units by the Federal Government in the form either of advice or of financing municipal and State needs to protect the holdings of the Government, or, through the assumption by the Government, of a banking function for the floating of State and municipal bonds. There are a number of Federal agencies interested in having material on the financial position of State and local governmental units kept up to date and readily available.

The decision on what is done with these bonds, or with future bonds of minor governmental units, obviously affects the possibility of cooperation between the Federal and local governments in the use of public works as a balance wheel for the control or amelioration of business cycles. There seems to be more than a possibility that through the wise use of the bonds now held by the Public Works Administration a continuing relationship among the financial programs of local, State, and Federal Governments might be built up which could be used as another weapon to avoid or reduce the violence of another depression.

Desirable Public Works Functions

Besides these activities of the Public Works Administration which must perforce be continued in one form or another, there are a number of others which might be utilized in the organization of an improved set-up of public works according to the steps suggested under the headings in the previous section of this statement.

The focal point in planning of public works is the presentation to the Congress by the President of a long-range program of public works—comprehensive in the types of work included and balanced to fit the needs of all groups and parts of the country. Such a program must be revised annually to meet new needs or changed conditions, but should always look at least 6 years ahead.

Preparation of a Program

For the preparation of a program for action by the President, and later transmittal to Congress, the Special Board of Public Works, or its successor, the Statistical and Projects Divisions of the Public Works Administration, and the Federal Employment Stabilization Board if transferred to the administration, might all be utilized. The legal basis of the Stabilization Office is ample to serve as the foundation for a new set-up along the following lines:

(1) The organization, as one of the coordinating committees of the proposed National Planning Board, of a *committee on public works*, consisting like the present special board of public works of representatives from all the major Government departments concerned. This committee might be presided over by an *administrator or deputy administrator of public works* who would present to it for consideration a 6-year program of public works revised annually. At a later stage, after approval of the program by Congress, proposals for the allocation of moneys to constructing agencies from any lump sum appropriated by Congress would also be referred to the committee before submission to the President for his approval.

(2) The Administrator of Public Works, in order to prepare the program and allot the appropriated funds, should have a staff under his direction including:

A Division of Projects, combining the present Projects Division with the Federal stabilization office, with duties as outlined in the Stabilization Board Act concerning collection of information on 6-year programs of Government agencies, and the further duty of recommending a coordinated and balanced program for action by the Board.

A second division would be needed to handle relations with non-Federal agencies and to negotiate agreements for the execution of projects in which the Federal Government may be concerned. This division would be set up for analysis of cooperative projects and proposed allocations to States, regions, or municipalities—such as Federal highway aid, flood-control projects, and such other aids or subventions for construction projects as may be authorized by Congress. This proposed division would be the contact agency with the National Planning Board in the development of statements of public works policy and in the preparation of plans for drainage basins or other broad categories of public works.

The present Division of Economics and Statistics could serve as the Statistical Division on public works in the sense outlined by the act establishing the Stabilization Board and would be the natural "information" center for matters relating to public works.

The coordinating committees on land, water, mineral, and power planning suggested in part I of this report, must be closely related to the proposed permanent organization of a Public Works Administration. These committees would be engaged in the stimulation, negotiation, and actual preparation of plans in cooperation with State and local agencies for public works projects involving a variety of jurisdictions and special Federal interests. River-basin projects involving Federal and local works are an example of the kind of plans which require the activity of some planning organization to secure agreements as to what should be done and how the responsibility and costs should be divided. To develop cooperation by the State and local governments, the planning committee and the proposed National Planning Board would naturally continue the stimulation and cooperative arrangements already started with State, city, and regional planning boards.

Reorganization of Construction Agencies

Under the suggestions in the foregoing paragraphs the negotiations, allocations, and supervision for the cooperative projects undertaken jointly by State and Federal interests would be handled by a division of a Public Works Administration. This activity would naturally include some of the work now done by the Bureau of Public Roads, and the Corps of Engineers in relation to flood control and similar projects.

The direct construction activities of these and other offices would benefit by pooling the engineering talent and construction experience in the several bureaus and it has been repeatedly suggested that they be brought together in a single agency. One way of securing this combination might be the organization of a "construction service" in the Interior Department, which would include the work now done by the Office of the Supervising Architect, the river and harbor work of the Corps of Engineers, the construction work of the reclamation service, and the direct construction now handled by the Bureau of Public Roads.

Since one of the purposes of such a consolidation would be to provide a pool of engineering experts, any Executive order or act of Congress setting up a "construction service" should provide for assignment of Army engineers to the service in the same manner that Army officers are now assigned to the Public Works Administration. This procedure would make possible the use of the expert services of the Army engineers and at the same time provide younger officers with opportunities for gaining experience in handling those large-scale projects to which their predecessors have previously contributed so notably.

SECTION II

VI. JURISDICTION FOR PUBLIC WORKS LOCAL, STATE, REGIONAL, AND FEDERAL

The organization for long-time planning of public works presents difficulties of the first order. In ordinary times over a 10-year period something like 25 or 30 billions would be expended for public works by various public agencies, 175,000 in number, local, State, and Federal.

These governments have independent taxing and borrowing power, subject to 48 different systems of State-local relationship. These areas, furthermore, vary widely in their financial position, ranging from comparative affluence to rigid restrictions and on into hopeless burdens of tax delinquency. Thus, all the varieties of control systems in our States and all the problems of areas in relation to property values are presented in an attempt to work out anything like an organized program of public works looking forward even for a short term of years.

These units, generally speaking—the United States Government (9 percent), the State government (17 percent), counties (20 percent), cities (48 percent),[1] towns and townships, school districts—common and high, plan and construct public works without special regard to each other. A city may have a well-considered city plan, but the Federal Government may set down a post office without regard to the local design of development. The State or the county may proceed to build public works at places and in a manner inconsistent with the other local programs. The school authority may disregard the city or the county. The result is often a waste of the taxpayers' money and a public-works development unsatisfactory in type.

Long-time public-works programs must furthermore be adjusted to different kinds of situations, such as a depression period, a normal period, a war-time period. In each of these instances a different policy must be adopted. But for these very reasons it is all the more urgent that the machinery be carefully set up and that it be capable of adjustment to meet changing conditions with the least possible loss and friction. A well-organized public-works system will respond to the needs of works relief or of war-time priorities without being thrown into confusion or hopelessly stalled into inaction.

In view of the wide variety of interests and jurisdictions involved, it is perhaps too much to expect a master plan for all the public works in any vicinity, but not impossible to arrange for systematic conference on the part of the several governments concerned and for better coordination of the works projects. This assumes, of course, that there is a general understanding in the community that it is desirable to cooperate in such undertakings and that the desire for economy and efficiency in works construction is strong enough to overcome local jealousies, inertia, and vested political interests.

I. It is suggested, first, that—

The Planning Staff of the Federal Public Works Agency might well address itself continuously to the task of considering statutory or administrative devices to facilitate effective cooperation between Federal and State or other local authorities dealing with public works. The broad Federal powers over interstate commerce and navigation especially, may be reexamined in the light of recent trends and of recent decisions of the courts. At the same time the large grants of financial aid to the States and localities by the United States make necessary a reconsideration of the terms and conditions upon which the economical and effective expenditure of such funds may be made, with justice to all the parties concerned.

Federal improvement areas, districts, authorities, may be set up entirely within a State or interstate improvement districts may be organized for wider purposes, assuming, of course, that adequate study has been made of the basic factors involved and that there is assurance of the social usefulness of such plans. Advance arrangements may be made with the States and localities before the grants are made, to the great advantage of the locality and of the United States. Memoranda may be prepared setting forth these conditions so that there may be a clear understanding of the nature and limits of Federal policy within this field, and time saved on occasions when action is urgent. Whether these arrangements should be embodied in statutory form is a question on which there may be difference of opinion. A sound principle would be the statement of broad general principles in the law, with wide latitude left to the administrative officials in practice, especially during the experimental period. The past experience of the United States in the construction of public works and in recent years the experience of the Public Works Administration and the Tennessee Valley Authority is very valuable for the

[1] 1925–29 figures

purpose of developing standard types of understandings and conditions regarding Federal-local financial and other relationships in the field of public-works planning. Likewise, the wide-spread experience of States in the formation and operation of drainage, conservancy, irrigation, and other similar forms of areas should be examined closely with a view to discovering such valuable principles as may be drawn from it.

One important aspect of this problem is the distribution of costs between various interested parties; the locality, the State, the United States, the user of certain facilities, such as power. This should be taken from the grab-bag basis and diplomatic dickering as far as possible and reduced to a fair and equitable basis. For example, it has been found useful in practice to provide that the State or locality shall acquire land necessary for sites. Rough measures have been made of the relative benefits to be derived from the various governments concerned, alloting a percentage of cost to each agency. But whether this should be fixed at 30 percent Federal, or 50 percent or 100 percent, has been the subject of much discussion, sometimes with more heat than light. In addition, however, to the difficulty of agreeing upon suitable division of the benefits and burdens, comes the problem of unequal ability to pay. Sometimes the local governments are very heavily laden financially and sometimes they are prostrate, while Uncle Sam always seems to figure in the role of Santa Claus. Indeed, the unequal territorial distribution of taxpaying ability, the weakness of our general property tax system, the financial resources of the Nation and the national control over credit and currency, make the problem a very complex one. What is fair under these conditions?

It seems not impossible that impartial boards or panels of assessors or appraisers might be set up in some instances, and authorized either to decide the ratio of financial burdens for the several localities, or at least to make advisory recommendations, which presumably would be followed.

An adjudication by persons of competence with technical knowledge of the necessary kinds of facts might provide a way out of many difficult situations. This might conceivably be brought about by judicial determination, but often time is of the essence of the contract and an administrative procedure might for this reason be preferred. Such impartial assessors might be appointed either by the United States Government alone, or by the different authorities acting in cooperation. Obviously no one of the authorities could be coerced into paying what seemed to it more than a fair share of the improvement cost.

II. It is suggested that State planning boards canvass the possibilities—

1. Of establishing sound relations with the Federal Government in the field of public works, and preparing such enabling acts as may facilitate the cooperation of State and Nation in public-works construction.

2. In the direction of interstate compacts and arrangements for projects running beyond State lines.

3. Of organizing programs of State-wide public works on the basis of long-time planning, with due consideration to national plans.

4. Of making easier the formation of unions of local authorities, or the formation of special forms of improvement districts either in urban or rural sections.

The States may meet the United States Government half way in the suggestion of division of authority and costs in public-works construction, and expedite the passage of such laws or the formulation of such understandings as may be necessary for this purpose. The State may also explore the possibilities in interstate compacts in advance in order to be prepared for such undertakings as may involve the joint action of several commonwealths. With such precaution taken it might be possible to avoid some of the long delays that have marked such negotiations as that preliminary to the Boulder Dam project.

The New York-New Jersey Port Authority affords an illustration of the possibility of joint action in a metropolitan area through the cooperation of separate States operating on the basis of State compact. This authority has developed a program of works and proceeded to the execution of a part of it on a grand scale. Unfortunately this authority does not cover the metropolitan region around New York in its entirety, and its activities are not tied in as closely as might be with those of the other governing bodies in the area. Other difficulties arise with regard to finances and adequate public control. While this organization is undoubtedly a step in advance, and should be welcomed as an important experiment in the coordination of some of the major public works of a great region, judgment may still be reserved as to the desirability of extension of this type of structure until there has been further opportunity to observe its trend and implications. Other State compacts have been made and these are available for study in the further development of like agencies, if, as, and where desired.

Long-time programs of public works are already under consideration by some of the State planning boards, and are likely to be the subject of discussion and action elsewhere in the near future. This proceeding will involve, of course, consideration of such a program in relation to the Federal program and to that of the various localities, rural and urban, and to regional developments as they may appear.

For local and regional coordination, a State might provide for a public works council or authority on a statutory basis and equip it with broad powers either of a consultative and advisory nature, or with powers of a

financial nature. In the simplest form such an authority might be given power to preview and preconsider all regional proposals for public works, and, if deemed advisable, to require reconsideration by the governmental body from which the recommendation originally came. In the amplest form a council might be given a qualified veto on local improvements of specified types, or the power to insist upon certain minimum requirements, or positive authority of its own to initiate and execute programs.[2] It might become the construction agency of districts desiring their services, or might construct and lease improvements to jurisdictions, or operate joint utilities.

Many States already have more or less complete laws permitting consolidation of local communities for one purpose or another—water supply, drainage, irrigation, conservancy, parks, schools, and other functions. These statutes are often inadequate, however, and could be restudied and recast with a view to the more comprehensive type of arrangement suggested here. A thorough revision of the local laws in the light of State planning possibilities as recently developed would make possible material progress in the direction of sounder works programs for many localities. For this purpose the services of the several State planning boards will be very important.

It has been suggested that it might be feasible to organize in many communities a public works council for consideration of the program of the community as a whole, including Federal, State, and various local agencies of government, assuming, of course, the appropriate integration of works programs with the more general aspects of local, State and national planning. Such a council might be made up of representatives from the various governments concerned and of civic or other organizations interested in the analysis of such undertakings. It might look at the program of an entire community with reference to the social utility of works proposed, their expense, their location, their style or symmetry of construction. It might consider and outline a long-time program of works, for a period of any 6 years, and recommend it to all of the governmental bodies involved.

It might be understood that no new public works should be undertaken unless the plan had first been submitted to this council and its report and recommendation received by the projector. The action of such a council might not, of course, be binding upon any of the Governments legally, but if its broad view of the situation met the approval of the people of the community, the effect might be material and the recommendation might indeed acquire as great force as a law.

The initiative in the construction of such an agency might come from any one of the several governments interested, but in any case the dignity and especially the leadership of the United States Government would be of great value. The technical advice of the Federal Government, its willingness to submit its own plans, and perhaps in some instances its financial assistance, would all have a substantial meaning in building up the necessary support and organization. If the particular community involved the cooperation of two or more States, the good offices of the United States would be especially useful.

Perhaps the metropolitan regions with their scores and even hundreds of independent taxing bodies offer the easiest road to the establishment of such agencies. Indeed, in cities like New York, Chicago, Boston, Los Angeles, Philadelphia, St. Louis, and elsewhere, official and unofficial regional planning associations have already been organized and have been of very great advantage at many points, even though only advisory in nature.[3] It has been suggested, however, that another step be taken in setting up a branch dealing with the particular problem of public works as a special part of the larger and more inclusive regional interest with which these planning bodies deal. A metropolitan public-works council might be of very great value in setting up a long-time works program, in considering particular works in relation to such a program, and in making the appropriate recommendations to all the jurisdictions involved.

Practical beginnings have been made in Boston and Cincinnati, whose experience in this field is most illuminating to all students of regional public works. Comprehensive consideration of a regional-works program and long-time budgeting of works has actually been set in operation in Hamilton County around Cincinnati, and with excellent results.

The problem is especially difficult where a metropolitan region flows over into two or more States, as around New York, Chicago, Kansas City, Cincinnati, and in a number of other cases. An economic and social community breaks through and over the earlier political boundaries and finds extreme difficulty in adjusting itself to the new conditions and organizing its structure and functions on a present-day basis. The historic survivals in the form of outlived jurisdictions persist with great force, strengthened at this point by the leadership of exclusive suburban groups ordinarily found in the forefront of movements for municipal reform but uniting for the moment with vested local political interests in common defense of their antique political ox carts.

As one-half of the population of the United States is included in the 96 metropolitan regions having a population of over 100,000, an important step would have been taken in the direction of balanced programs of works and of master plans for the greater part of the

[2] See Merriam, Parrat & Lepawsky. The Government of the Metropolitan Region of Chicago.

[3] See list of regional planning agencies—Eleventh circular letter. National Planning Board

country, if such metropolitan councils came to be the rule. This would be true whether the councils were merely advisory in character or endowed with larger legal and financial authority. If now these metropolitan councils were brought together in conference with the planning board of the Federal Public Works Administration, there would be opportunity for consideration in a large way of the public-works program of a great part of the United States. It would, of course, be possible to assemble special regions for conference with each other and with the central public-works agency.

The same principle of organization would apply with equal validity to other types of region than the metropolitan. Indeed in the sparsely settled sections of the country, where governing bodies are often small and financially weak, concerted action in the planning and construction of public works is of the very greatest importance. These communities are usually as deficient in competent technical advice on planning and in construction as they are in financial strength. If their capacity for cooperation is equal to the emergency however, it would be possible for them, especially with the help of the United States Government, or without as might be, to put together an organization of distinct value from the point of view of finance as well as of technical service.

Many of these smaller governing bodies might well be brought together under some legal framework authorized by the State, but if this is not feasible, the wide road toward cooperation is always open. State planning boards might well take the initiative in calling attention to the possibilities at this point, in aiding in the formulation of the necessary agencies, and in further relationship of the local works program to the larger planning program of the entire State.

Furthermore, forms of organization such as the Tennessee Valley Authority must be carefully scrutinized as they develop with a view to discovering the soundest form of organization and procedure adapted to the special needs of different localities and to the various functions performed, such as power, production, flood control, and water supply. The adequate planning of our national resources is not unlikely to require the construction of a variety of jurisdictions adapted to the new problems arising. Fortunately our system of Government is flexible enough to permit many diverse and experimental forms of political structure and is adequate to any emergency that may arise.

Our experience with the Tennessee Valley Authority may well serve as a basis for consideration of other like or varying types of large-scale organization of governmental functions or authorities in other areas. The various relations with States, with county and other local governments, with private and quasi-private agencies, will prove of inestimable value in the inevitable regrouping of our governmental agencies and functions that is demanded alike by considerations of economy and of public service.

It is altogether too early to draw dogmatic conclusions regarding the best methods of organization for the protection and development of our national natural resources, and for the accompanying improvement of our American standards of living, but it is already plain that we must follow the problem wherever it leads, whether across State boundaries or into the intricacies of outworn local government or the equally difficult complexities of metropolitan life. It is one of the functions of the National Resources Board to observe carefully all such trials, to assemble the basic facts, to interpret them, from time to time as occasion warrants.

Nor can we omit consideration of such organizations as the county associations for purposes of crop control under the A. A. A., or the forms of community life clustering around the newly created subsistence homesteads; for these are important developments of the democratic governing process. It is useful to bear them in mind constantly in the formation of agencies for the development of our national resources. Nor can the formation of types of industrial self-government and discipline such as the National Recovery Administration be left out of the picture even of natural resources. These groups are intimately and inevitably related to the use of our resources, as is clearly evident in the case of lumber, minerals, and public works involving the organization of intercommunication, transportation, or the application of forms of power, electrical or otherwise. These groups are forming novel types of association, but well within the scope of our political system, and in any case highly important to consider in the formation of governmental agencies designed to promote the highest and best use of our natural and all our national resources.

Quasi-governmental agencies are likewise of significance in the prospectus of the possibilities of reorganization of our resources. The Panama Zone and the Inland Waterways are examples of organization and activity worthy of close study in the systematic effort to provide the most promising mechanisms for cooperative action, notably in such fields as power and transportation. The border line between government and industry is rich in unexplored possibilities or reorganization.

Some of the emerging relationships in our national life are likely to require cooperation not only of national, State, and local authorities, but private and quasi-public agencies as well, and we may use our best constructive imagination and practical skill in order that this task may be most efficiently performed. In power production, transmission and distribution, there is an

important illustration of a problem which may require the joint organization of a variety of governmental and quasi-governmental units.

Our governmental system lends itself to an abundant variety of arrangements varying widely from State to State, in accordance with varying constitutions and customs. The limits of possibilities in such undertakings have never been approximated. Viewing the rapidly shifting conditions of our time, and especially the changes in means of transportation which revolutionize our local idea of distance, it is important that those situations be thoroughly recanvassed with a view to recasting structures that have become obsolete with the rush of modern events.

The local governments, urban and rural, are no longer isolated largely from the Federal Government, but are united by ties of increasing number and strength. The Rural Mail Delivery, the county agent, the cooperative associations, the Health Service, the Federal Bureau of Roads, the Department of Agriculture; these and other Federal agencies are binding the United States more and more closely to the parts of which it is made up. The Federal services rendered to municipalities are many and important and increasingly significant for the life of the city,[4] notably in relief, in housing, in relations with industry and labor.

A small measure of ingenuity and a large one of good will would make possible many comfortable arrangements between governments otherwise indifferent to each other, and perhaps forgetful of the fact that they serve the same people. It would be possible, for example, to unite several types of official duties on different jurisdictional levels in one and the same person, who might become an agent of three or more masters at one and the same time—a local official with State duties as well, or with some national duties which could be conveniently carried on his official shoulders without weakening his backbone; or a State or Federal officer as the case might be.

In rural communities the county agent has served a very useful purpose in drawing together various forms of governmental agency, and uniting them for emergency purposes at least, although the county is obviously an awkward area under modern conditions. No similar center has developed, however, in the urban communities, where a multitude of local, city, county, State, and Federal authorities operate side by side, but often without that degree and type of cooperation desirable in the interest of economy and of public service. This carries us however, into the broad field of closer cooperation among officials of different governmental levels—a topic of large and increasing importance in the movement toward the elimination of excessive governmental costs and the development of effective cooperation between levels of government and official personnel. This is a subject which requires thorough study in the immediate future with an eye to the development of constructive proposals reflecting the emerging governmental problems. In dealing with our natural and our human resources alike, the invention of new and flexible arrangements will save both time and money.

Far from injuring local or central government, such readjustments would in reality strengthen them, by allocating functions and powers to appropriate agencies and units. Instead of leaving the smaller units of government to starve or eke out a miserable existence in many cases, it is possible to revive and restore them by setting them up in a vital relationship in which they may function practically instead of theoretically.

It follows further that if regional councils, agencies, or authorities, both urban and rural in scope, were set up throughout the country, they might be given a form of national coherence and coordination through the friendly initiative of the central public works agency of the Federal Government. The great fund of technical knowledge of the United States engineers could be pooled with that of the States and cities. The financial problems of public works could be analyzed in comparative fashion. Inventive minds might well devise ways and means of using more effectively that portion of our national resources now devoted to public works. Naturally these groups would be in close touch with the Public Works agency of the United States composed of responsible governing officers in this field. They would also find it important to keep in close touch with (1) the American construction industry as a whole, (2) with those agencies of Government responsible for the time of public works in periods of industrial depression, as well as (3) with the relief agencies interested in works relief. Such centralized consideration of public works would, of course, be only distantly related to the work of the President's Planning Board, through which works would be tied in with the general welfare of the Nation. The President's board would deal with those activities in relation to over-all planning, and chiefly through the instrumentality of the Federal works agency. In this way, while local initiative might be preserved, the President's board would be spared the danger of suffocation by the dust of detail.

In a still broader sense these activities and plans would raise important questions among credit agencies regarding capital allocation to construction—a problem of interest to the fiscal branch of the Government, to the National Recovery Administration perhaps, and to the banking and credit organizations of the country. The place and balance of public works might be considered along with the broadest aspects of the National Budget.

[4] See Paul V. Betters, Federal Services to Municipal Governments, Brookings Institute, 1931

Our costly experience with devastating public confusion, with waste of all kinds, with projects inadequately investigated and planned—with political scandal, with inartistic outcomes, caused by the independent action of 175,000 governing bodies, indicates the urgent need of prompt steps in the direction of more affective concert of action. Even the most rugged of individualists cannot insist upon the general freedom of spending involved in such unlicensed liberty to build. Every proposal in this field is worthy of sympathetic consideration on the part of those concerned with important national problems. There is nothing in the American situation, except inertia, to stand in the way of far closer relationship on the part of public works authorities. We may realize far-reaching advantages from the comprehensive view of the whole field, from the free interchange of information and experience, from the pooling of technical knowledge and facilities, from mutual consideration of credit situations, from such general advice and supervision as is not inconsistent with the requirements of vital self-government.

Indeed in no aspect of American public affairs is there better opportunity for broad consideration of local and regional phases of planning, and at the same time of fertile relationship between these regional points of view and associations with those of the Nation as a whole. All the way from the local advisory council to the Federal Public Works Planning Organization, there is opportunity for free interchange of planning ideas and programs, and for the growth of adequate forms of cooperation, which the law cannot readily set down in advance but which right goodwill may translate into effective understandings, into going concerns, and perhaps eventually into the forms of law.

It should be clearly understood that the organization of local and regional agencies is and should be primarily the responsibility and opportunity of the localities themselves, and that any aid rendered by the Federal Public Works agency should be collateral and incidental. In a national program of public works, soundly conceived, there is abundant room for the development of local initiative and activity, and indeed without this the fullest results cannot possibly be attained. It is in a skillful balance between the overhead role of the Federal Government and the role of the localities and regions that wisdom lies. It cannot be too often reiterated that national planning does not involve or permit the centralization of all planning at the center, but presupposes a free flow of ideas, experiments, experience from circumference to center and back again to the circumference.

While in the preceding paragraphs attention has been directed especially toward the possibilities of coordination of authorities dealing with public works, it is also important that such agencies should be developed in close relation to other types of local authority dealing with other governmental functions, not primarily classified as public works. Local planning and coordinating agencies of many kinds are likely to develop in the necessary process of reorganizing our local governments to meet the conditions imposed by modern ransportation on the one hand and present-day local finances on the other.

Public works is one aspect only of local government, and it is not desirable that works authorities should stand in the way of other and more inclusive planning agencies growing out of the needs of various communities or regions.

PART I—SECTION III
STATE AND REGIONAL PLANNING

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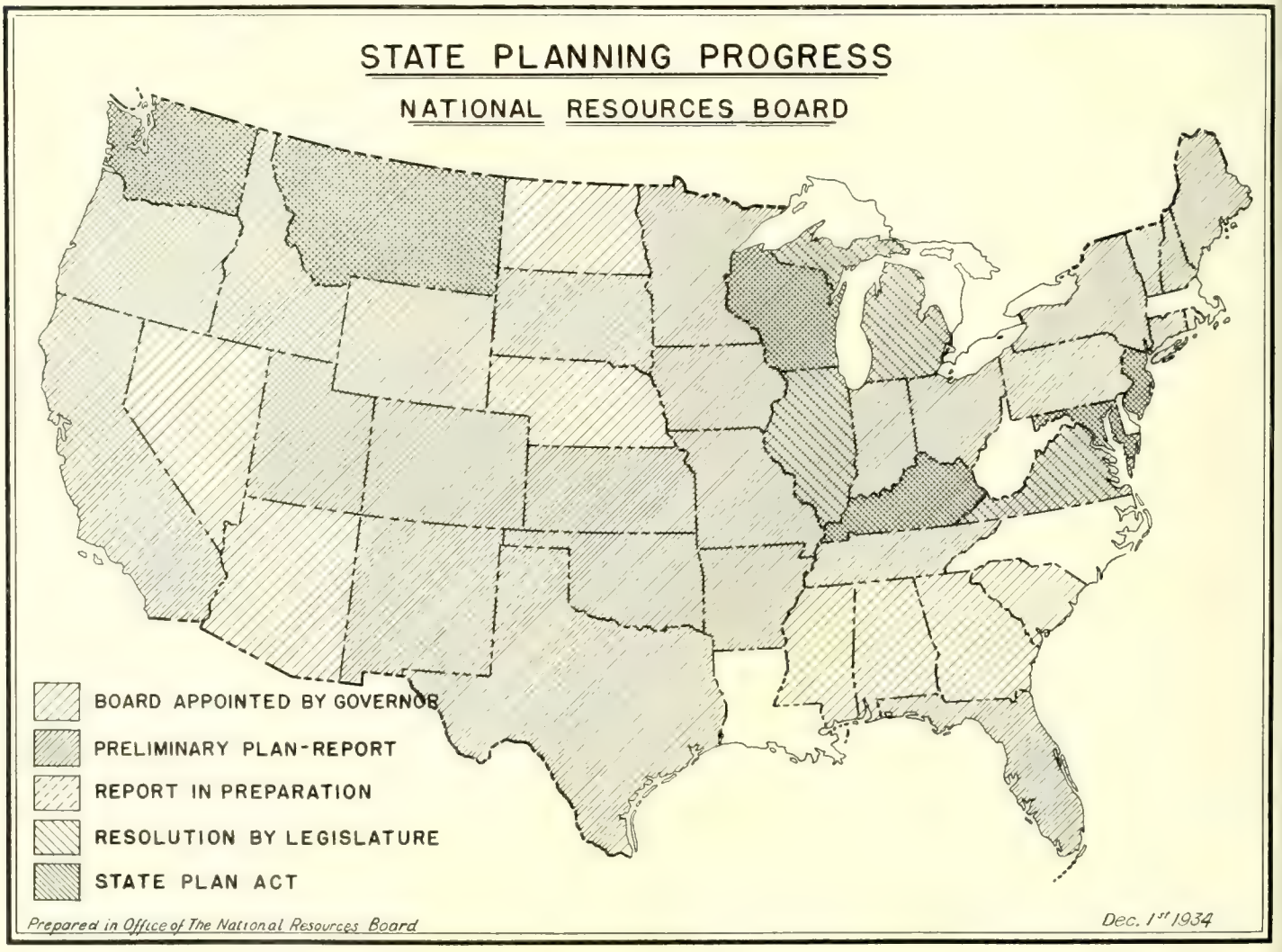
SECTION III
I. STATE AND LOCAL PLANNING

Some of the potentialities and difficulties which may be encountered by an advisory planning agency have been explored during the last year through the development of over 40 State planning agencies and several interstate planning organizations. Our Federal system makes possible laboratory experiments under a variety of circumstances in the several States, and this possibility has been fully used.

When the National Planning Board suggested to the governors of the States the possible desirability of State planning work, and offered the assistance of consultants, it was hoped that perhaps as many as 10 States would set up planning boards and that four or five good reports might result. Forty-two States now have official boards appointed by their governors. To these boards, consultants were assigned by the National Planning Board and the National Resources Board when certain reasonable conditions were met by the governors concerning office space, staff, and assurances of sponsorship and continuity. Most of the boards have received further assistance through the relief organization in the form of stenographic, drafting, and other technical help.

The consultants to State and regional planning agencies assigned by the National Resources Board, have been asked to submit a report on their first 6 months' work, and these reports, which are now being



assembled in the office of the Board, show a remarkable and healthy variety of approach and of interests.

Variety of Sponsorship and Support

Republican and Democratic governors alike have appointed State planning agencies to plan for the future of their respective States. Politics seem to have played little or no part in the choice of planning board members. Business interests have been active in the movement through the State Chambers of Commerce in such States as Montana, Kansas, and Texas, and through the New England council in the case of the New England Regional Planning Commission. In a number of States, the universities and colleges have taken a leading part so that university officials appear as chairmen of the planning boards of Ohio, Missouri and Minnesota, and have representation on practically all of the boards.

Organization Differences

Not only is there variety in the sponsorship of these new planning agencies, but there are also great differences in their membership and organization. The largest board, for instance, has 22 members, and the smallest numbers only 5. Most of the State planning boards were originally appointed with some members drawn from among the department heads most concerned with current planning proposals serving ex officio. Opinion varies as to the advisability of that method of selecting members, and some of the boards are recommending in the bills to be submitted to the State legislatures this winter that provision be made for citizen members only who can give practically full time to the work. From other States, word comes that the membership of State officials on the board has been a major influence in securing much needed coordination within the State government on a number of important projects.

Similar differences are found in the present organization of the various boards as well as in opinions on desirable staff. Most of the States are using personnel furnished through the State relief administrators—on a part- or full-time basis. Estimates for minimum budgets to carry on the work vary all the way from $10,000 for a biennium to $50,000 annually. Besides the help received from the Emergency Relief Administration and the universities, several State planning boards have secured aid through grants from foundations and from other sources.

One of the most encouraging features of the State planning work has been the diligence with which the people employed have applied their talents and the personal interest they have taken. With the fear of unemployment temporarily removed, the constructive nature of the work stimulated their imagination and enthusiasm. Whether or not they were on a part-time basis and in spite of the meager salaries they received, the staffs have labored devotedly. By giving work to these engineers, architects, draftsmen, statisticians, and others of the white-collar group on work in their own or related fields, the Federal Emergency Relief Administration has been making a most valuable contribution not only to the planning movement but also to the restoration of the morale of this important class of unemployed, an achievement of no small consequence.

Already several bills [1] and resolutions [2] have been passed by State legislatures to put the work of these boards on a permanent basis, and endorsements of proposed bills for presentation in the next sessions of the legislatures have been forthcoming from almost all of the governors to whose boards consultants have been assigned.

Interests and Recommendations

A wide variety of interests and recommendations naturally appears among the State planning boards, for obviously conditions in densely populated and well-watered eastern sections are radically different from those found in the dry, sparsely settled mountain States of the West. As a result of these natural conditions, water resources loom largest in the reports from the Western States, and population problems figure prominently in reports from New England, New York, New Jersey, etc. Yet there are features common to many or all of the reports.

In all of the reports the relation of the State planning agency to local planning units and their problems is given some consideration. There are now over 800 city planning commissions, though many lack authority and financial support. It seems certain that interest and progress in State planning will have a salutary effect on city planning which in many places was quiescent or moribund. Many of the preliminary reports of the State planning boards recommend additional authority and powers for local planning efforts, and the suggestion is made that one of the functions of the State planning board should be to serve as a clearing house for exchange of information and to provide assistance to local planning agencies. Experience in Massachusetts and Pennsylvania over a period of years has revealed both the possibilities and the dangers of that procedure.

A second similarity among the reports now coming in from the consultants assigned to the State planning boards is emphasis upon population studies. Interest in the problem of decentralization of industry and in the movement for housing and subsistence homesteads appears to be Nation-wide.

[1] Maryland, New Jersey, Kentucky, Wisconsin, Washington, and Montana.
[2] Illinois, Virginia, and Michigan.

These interests have led naturally into problems of land use, which fill many more pages than any other single subject treated by the State planning boards. Land planning consultants have been assigned by the National Resources Board first to gather material needed for the land section of this report and second to develop land use studies for the State planning boards. As a basis for adequate land planning, several State agencies are urging completion of the national mapping program for further work on the soil survey, census of farm structures in problem areas, and study of soil erosion. One State planning board is advocating the establishment of a new public domain, while others have recommendations for extensive forests and park purchases. In several cases recommendations are made for withdrawal of submarginal lands. The possibility of using submarginal areas for recreation has been fully developed in reports on conditions in such recreation States as New Hampshire and Minnesota, and other States have made special studies of their historical and scenic sites from the recreational standpoint.

In accordance with suggestions from the National Planning Board, and owing to the interest of the Public Works Administration and the Emergency Relief Administration, some excellent programs of public works and emergency works have been prepared under the auspices of the State planning agencies. One of the most complete statements in this field which has come to our attention was worked out by the Indiana State planning board, which has presented a program of public works, relief works with funds for materials, and straight work-relief projects. All kinds of public works are recommended in the various reports, ranging from housing, grade-crossing elimination, surveys and traffic counts, to flood and power projects—in fact, the whole gamut of public construction activities. Two States for instance, have made exhaustive studies of the future needs of various counties for schools and educational plants.

Water planning is still another general subject dealt with in practically all State planning reports in the broad sense in which such studies have been defined by the water planning committee of the National Resources Board. Recommendations in these cases naturally overlap those in the field of land use dealing with forestry and soil erosion, but include such novel suggestions as the zoning of river flood ways.

A final field of common interest seems to be that of transportation, particularly in relation to highway construction and programs of State highway commissions. Much interesting material on competition among methods of transportation and overlapping services appears in the reports, and indicates the necessity for coordination of transportation methods.

The need for integration of State policies has been recognized for some time, and planning work has been carried on by various agencies in efforts to secure coordination. The movement for legislative councils bringing together executive and legislative policy is one example of such planning. A variety of experiments by such councils and by planning boards is desirable and there is no reason to fear serious conflict among them. In fact, it would be a natural development for planning agencies of various sorts to combine, as they have already done in Kansas and Virginia.

The experience of the last 6 to 9 months of State planning board activities has demonstrated the possibility of further development of local agencies to decentralize planning work and to stimulate local and State interest in and responsibility for the future of towns and counties, regions, and State or interstate areas. It seems probable that if further assistance is available from Federal sources, State planning boards can be utilized individually or in combination for the coordination of State activities and for initiating programs, policies, and projects in the same manner as the proposed National Planning Board outlined in the following chapter of this report would operate.

In the preceding sections of this report reference has repeatedly been made to the need for a central agency in each State with which Federal land, water, mineral, and public works organizations can deal. Various cooperative projects, surveys, and planning proposals have been suggested which involve Federal assistance to State agencies and which fully justify the Federal Government in encouraging and aiding State planning boards.

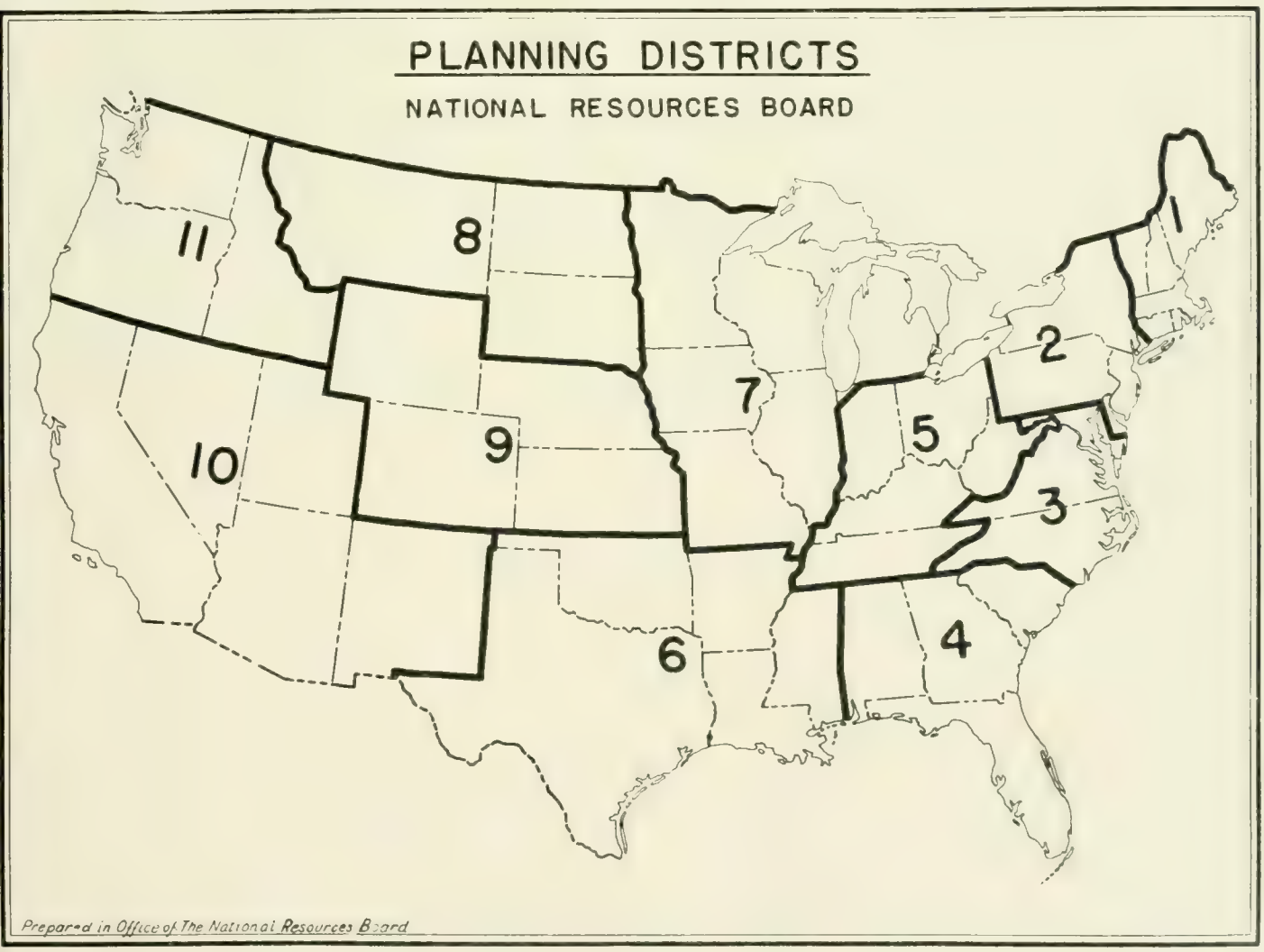
Conditions under which assistance may be provided will naturally vary from case to case, and certainly should not take the form of interference in State affairs. If there is an official State planning body, it would seem entirely proper to have consultants available from the proposed National Planning Board who could advise and assist them in the organization of special studies and suggest methods of procedure found helpful in other States. One consultant might serve more than one State in this general capacity especially if a regional organization of several states has been set up.

SECTION III
II. INTERSTATE AND REGIONAL PLANNING

Besides the extraordinary growth of the State planning movement in the last year, or perhaps because of it, new interest has been aroused in interstate or regional planning organization.

Through regional advisers of the Public Works Administration, and later through the district chairman of the National Resources Board, an informal contact was established for interstate collaboration on joint planning projects. In two regions these informal contacts developed into more complete organizations or regional planning commissions. Both the New England and the Pacific Northwest planning agencies are composed of representatives of the State planning agencies with other interested citizens, and in both cases large advisory committees have been set up to keep in touch with public opinion and to secure the help of Federal, State, and private organizations. Both of these commissions are served by consultants assigned from Washington, in the same manner as State planning consultants are assigned to State planning boards.

The New England Regional Planning Commission is loosely organized to adjust interstate problems rather than to initiate regional projects. It has grown directly out of previous planning studies fostered by the New England council and by the conference of governors of the six States. It has no authority, but has already proven its value as a coordinating agency.



The planning work in the Pacific Northwest is much more centralized in the office of the district chairman because the major problem of the area affecting all four States is the Columbia River development at Grant Coulee and Bonneville. The organization developed by Mr. Marshall N. Dana is another agency again without specific legal authority but actively engaged in planning for the Columbia Basin although in a fashion widely different from that of the Tennessee Valley Authority in the southern section of the United States.

These two new agencies, one based on history and custom, and the other on the unity of a great drainage basin, have been aided in the last few months to the previous experiment going on in the Tennessee Valley and to such arrangements as the Colorado River compact, the Port of New York Authority, and similar agencies which have legal buttresses to support their planning work.

The Tennessee Valley Authority is in marked contrast to the New England and Pacific Northwest experiments in that its centralized planning is conducted entirely at an initial Federal expense to be later recouped. It is decentralized in area but not in jurisdiction, for it is a Federal authority without State participation. The Colorado River compact, on the other hand, has encountered difficulties because of failure to secure unanimous State cooperation. It is too soon to judge the relative merits of these or other ways of developing regional and interstate planning programs, but it is encouraging to find a variety of methods and a similarity of ultimate aim, and such enthusiasm in widely separated parts of the country.

If further assistance is to be provided in the form of consultants to State planning boards, some kind of regional organization would seem to be essential to secure interstate cooperation. Until greater experience has been obtained in the various laboratories where trials are now being made, it would seem wise to try a variety of methods with Federal backing rather than to commit any large sum to repetition of the same experiment in several regions before the relative advantages of the various methods now under trial have been clearly demonstrated.

Variety of Regions

Federal agencies have divided the country into regions or districts for administrative, planning, and other purposes with little or no attention to the divisions used by other bureaus. It is natural and perhaps inevitable that the special situations and needs of different agencies should result in drawing different boundaries for regional subdivisions of the "field." Studies of water, for instance, logically must be laid out along the lines of drainage basins, while others can use State lines and combinations of States. The Federal Reserve districts were arranged to include a certain number of banks of given capital.

If coordinated planning is to be successful, some degree of order must be brought out of the present chaos of regions and districts. It seems reasonable to suppose that a large number of Federal agencies could use the same regional divisions without serious detriment to their work. A careful analysis of the advantages and difficulties of using more uniform district boundaries in Federal planning and administration is a next step. It would be pedantic, of course, to let a desire for uniformity interfere with the varying requirements of different tasks; but many of the present confusing divisions of the country appear to have no justification beyond the traditions of the bureaus by which they are used.

PART I—SECTION IV
BASIC DATA FOR PLANNING

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SECTION IV
BASIC DATA FOR PLANNING

Wise planning for our national resources—human and natural—depends upon the adequacy and integration of the factual data and surveys upon which it is based. Great quantities of research material have been collected and millions of dollars expended by our Government agencies, universities and scientific organizations, and still there are yawning gaps in our information. New methods of making available material in forgotten pigeonholes and data in new fields are both needed.

Among the many kinds of basic data needed for wise planning, the following major requirements deserve immediate attention:

I. A Financial Balance Sheet

For appraisal of our national resources, a statement of the financial position of the United States as a whole should be available. This should begin with a balance-sheet statement of resources and commitments, or assets and liabilities. The preparation of such a statement was provided for by the act of Congress which set up the Federal budget system and created the office of Comptroller General, but as yet no balance sheet has been set up for the Federal Government. It is realized that the task is not an easy one, but for all that, we believe that such an analysis of financial resources and commitments is not only desirable but essential.

The Institute of Government Research, a department of the Brookings Institution, has for upward of 10 years worked on this problem and has printed a number of reports on the subject. Several of our States have set up balance sheets of this kind, notably New Hampshire. Important cities of the country very generally have adopted this form of statement as a basis for their bookkeeping, and it is unnecessary to say that every corporation of importance in the country, whether a public utility or a wholly private organization, begins by making a balance-sheet statement. Some 70 units of the United States Government have set up such statements, but there are no corresponding figures for the Government as a whole.

The National Resources Board believes it is necessary that such a statement be set up by the Comptroller General and that the facts presented would provide a basis for sounder thinking about national resources and expenditures for permanent, as distinguished from temporary purposes. No large business enterprise would be satisfied with a mixed account of capital expenditures and current operating expenses such as the Federal Government uses today. A clear distinction must be drawn between current operating expenses on the one hand and investments for which repayment is provided on the other hand.

For the same reasons, the Board urges the need for corresponding balance sheets showing the situation of cities, towns, counties, and States. Current data on these matters should be available not only for local use by interested citizens but also for Federal departments and bureaus.

II. Population—Composition and Movement

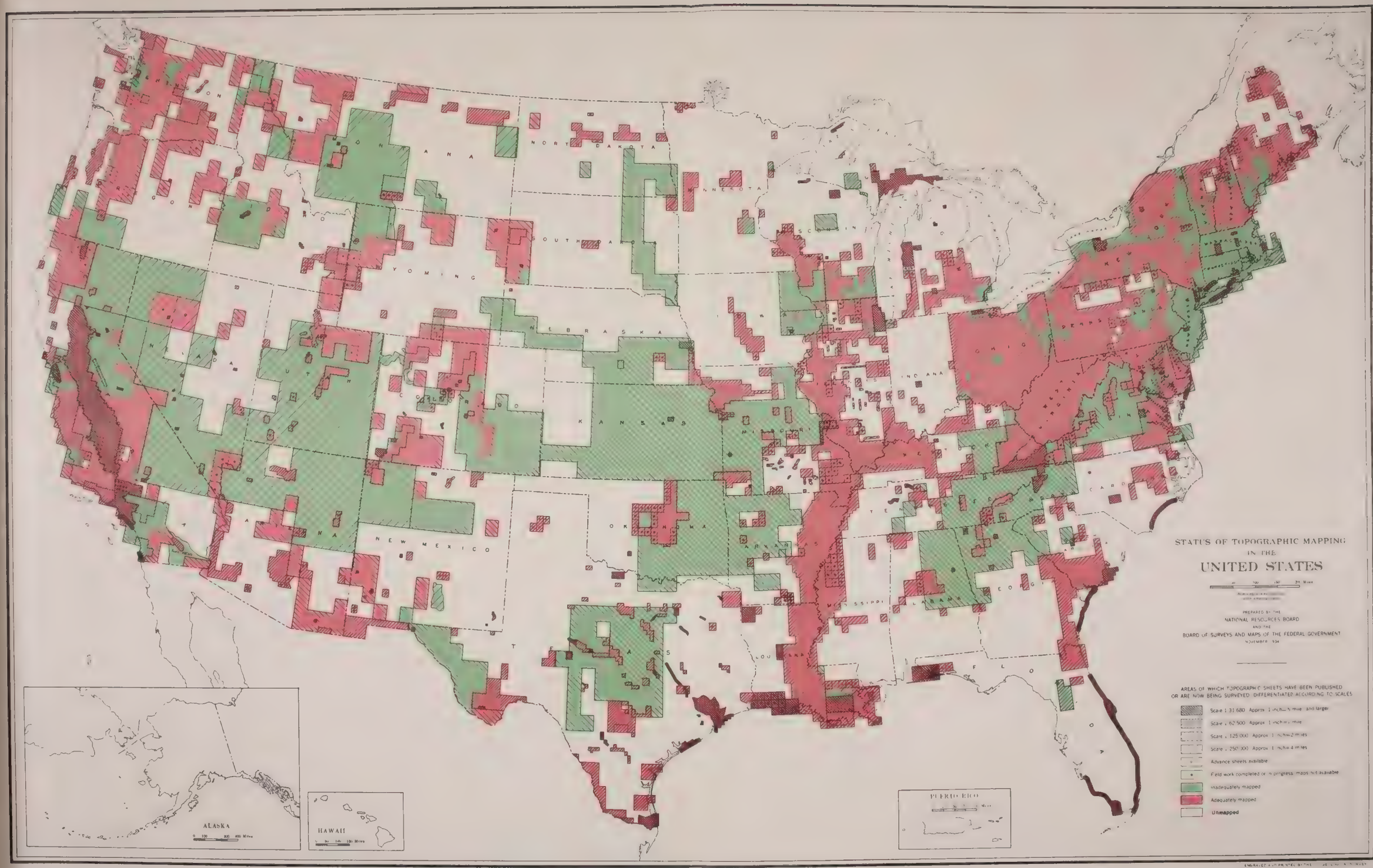
Through the decennial census, a record of population changes has been kept since 1790 covering many aspects of our human resources. The cost of making the detailed classifications which would meet the various and minute demands of social scientists and statisticians has prevented the Government from developing the full value of its data, and requests are continually made for more adequate information. Not only is the classification incomplete in some lines, but the 10-year interval is over long in periods like the present when weighty decisions of policy must be based on guesses as to trends since the last census was taken.

In the judgment of most experts, far-reaching changes have probably occurred during the last few years in the distribution of population between city and country. Planning for human use of natural resources must be make-shift planning if we do not know where the people are for whom we are proposing new developments or more effective use of present plant.

There is no need to enlarge upon the lamentable fact that accurate figures on unemployment are not available despite our sore need of them. In this connection, it may be noted that the taking of a census itself would provide useful employment for several thousands of people.

A special census of population and employment was proposed last year, to be taken in connection with the Census of Agriculture, at an estimated cost of approximately $7,500,000.[1] A separate census for 1935 may

[1] See hearing before Committee of the Census, 73d Cong., H R. 9391; H. Rept. No. 1680, 73d Cong.; and S. Rept. 1165, Calendar No. 1241.


STATUS OF TOPOGRAPHIC MAPPING
IN THE
UNITED STATES
PREPARED BY THE
NATIONAL RESOURCES BOARD
AND THE
BOARD OF SURVEYS AND MAPS OF THE FEDERAL GOVERNMENT
NOVEMBER 1934
AREAS OF WHICH TOPOGRAPHIC SHEETS HAVE BEEN PUBLISHED OR ARE NOW BEING SURVEYED DIFFERENTIATED ACCORDING TO SCALES
Scale 1:31,680 Approx. 1 inch = ½ mile and larger
Scale 1:62,500 Approx. 1 inch = 1 mile
Scale 1:125,000 Approx. 1 inch = 2 miles
Scale 1:250,000 Approx. 1 inch = 4 miles
Advance sheets available
Field work completed or in progress; maps not available
Inadequately mapped
Adequately mapped
Unmapped
ALASKA
HAWAII
PUERTO RICO

prove somewhat more expensive, but from the planning point of view it would be well worth the cost.

New techniques should be developed for making estimates of population and unemployment in the intervals between the five- or ten-year periods when the census is taken.

III. Mapping

In both the land and water sections of this report, frequent references are made to the need for completing the topographic mapping of the United States. Less than half of this country is now covered by topographic maps, and only 25 percent of the United States may be termed "adequately mapped" according to the Federal Board of Surveys and Maps.

Adequate maps are absolutely essential to land and water planning and are valuable in scores of different ways. The great value of maps to highway officials has been forcefully stated by their national organization, and similar values would accrue to a variety of other engineering and industrial activities if adequate maps were available. A long list of Federal agencies add their requests for topographic data covering areas not yet mapped.

With this situation before it, the Board of Surveys and Maps of the Federal Government has prepared a report on a "National mapping plan" which comprises part V of this volume. In brief, the plan proposes the prompt completion of a topographic base map of the United States at scales of 1 : 62,500 (inch=1 mile, approximately) and 1 : 125,000 (inch=2 miles), through the use of air photography and other modern methods at an estimated cost of $117,531,000 over a period of 10 years. The Board of Surveys and Maps includes representatives of 28 map-making agencies, and its recommendations are the outcome of long experience.

The Science Advisory Board has also realized the importance of an adequate map of the United States, and in its report on "The mapping services of the Federal Government" says that "It would be difficult to exaggerate the importance of providing for the entire country at the earliest possible date a standard topographic map adapted to the most urgent needs of the people." The Board's report suggests reorganization of some of the mapping services in an effort to increase efficiency and to reduce the cost of making such a standard map.

The National Resources Board adds its endorsement of the proposal for an adequate map and urges its early completion by the most economical methods and the most suitable form of organization.

IV. Climatology and Climatic Risks

For both land and water planning, new research is needed in climatology to define climatic risks. This need has been clearly set forth in the land and water sections of this report in connection with statements concerning the zones of hazard in agriculture and grazing and concerning the amount of water available for use in power, irrigation, and other projects. A year ago, the Science Advisory Board in a "Preliminary report of the special committee on the Weather Bureau" laid down a program for research in this field. Among the important elements is a study of air mass methods of forecasting weather and a phenologic survey. Phenology deals with the seasons at which certain critical plants or trees begin to put forth their leaves. A phenologic survey would provide valuable information on the length of the growing season in different parts of the country.

V. Water Studies

Additional research and data are needed for the water program as shown in the report of the water planning committee. That committee emphasizes the need of

(*a*) Extension of the system of permanent gaging stations on important rivers.
(*b*) Systematic inventory of water resources.
(*c*) Studies of ground water.
(*d*) Studies of water supply and sanitation in relation to public health.
(*e*) Research in respect to water quality and standards.

VI. Soils

The land report stresses the need of immediate action to control erosion and, as one of the important elements in that effort, suggests further study of soil in relation to slopes and surfaces. This type of work has been experimentally carried on by the Soil Erosion Service during the summer of 1934 on the Navajo Indian Reservation.

Soil-fertility surveys and soil classifications also need to be carried further. Only one-half of the agricultural area of the country has so far been covered by soil surveys. A beginning has been made on the classification and inventory of land types according to inherent physical productivity. Both types of work are basic to land planning, and the land report suggests that both should be rapidly extended.

VII. Vegetation

As further aids in the campaign to check erosion and other types of deterioration of range lands, studies are recommended of the types of vegetation best adapted for such uses in various parts of the country, on soils of different composition and in locations of different character. Primitive or planted reserves in each vegetation region of the United States are considered essential in studying ecology and the natural grouping of vegetation

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(*a*) Extension of the system of permanent gaging stations on important rivers.
(*b*) Systematic inventory of water resources.
(*c*) Studies of ground water.
(*d*) Studies of water supply and sanitation in relation to public health.
(*e*) Research in respect to water quality and standards.

VI. Soils

The land report stresses the need of immediate action to control erosion and, as one of the important elements in that effort, suggests further study of soil in relation to slopes and surfaces. This type of work has been experimentally carried on by the Soil Erosion Service during the summer of 1934 on the Navajo Indian Reservation.

Soil-fertility surveys and soil classifications also need to be carried further. Only one-half of the agricultural area of the country has so far been covered by soil surveys. A beginning has been made on the classification and inventory of land types according to inherent physical productivity. Both types of work are basic to land planning, and the land report suggests that both should be rapidly extended.

VII. Vegetation

As further aids in the campaign to check erosion and other types of deterioration of range lands, studies are recommended of the types of vegetation best adapted for such uses in various parts of the country, on soils of different composition and in locations of different character. Primitive or planted reserves in each vegetation region of the United States are considered essential in studying ecology and the natural grouping of vegetation

in relation to the soils and uses of areas. Overworked and exploited tracts should receive analysis and study with a view to developing economical methods for their regeneration.

VIII. General Research

Finally, it should be noted that most of the scientific bureaus of the Government have continuously in process a wide variety of research projects, many of which may contribute toward wise planning for the use of our national resources. The National Academy of Sciences and the Social Science Research Council in their statements upon "The contribution of science to national planning", published in the report of the National Planning Board, indicates the variety and importance of the studies conducted by Government bureaus, universities, scientific organizations, and private investigators. Proposals for extending certain lines of research and initiating new lines are under consideration by the Science Advisory Board.

While new data are needed in certain directions, perhaps the most pressing immediate need is to bring together and coordinate the immense quantities of data already available or now being gathered by many bureaus and departments of the Government.

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A PLAN FOR PLANNING

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SECTION V
A PLAN FOR PLANNING[1]

A review of the problems encountered in the examination of land, water, minerals, and other natural resources, and of a public-works program indicates the necessity of advance planning in these fields, if the best results are to be obtained. When attention is directed to other aspects of national policy the same conclusion becomes increasingly apparent. It is important, then, to consider the most practical forms of organization for dealing systematically with national resources, both natural and human.

In 1931, Gov. Franklin D. Roosevelt, when addressing the New York State Agricultural Society on the subject of agricultural planning, declared that "in the long run, State and national planning is essential to the future prosperity, happiness, and existence of the American people." He made it clear that the planning needed is cooperative planning for the common good that does not force industry or citizens into a fixed pattern of conduct. As President of the United States, Mr. Roosevelt has on numerous occasions, and particularly in his message to Congress of June 8, 1934, repeated and amplified this notable declaration.

The report of President Hoover's Research Committee on Recent Social Trends, published early in 1933, considered at great length the developments in the United States during the last quarter of a century, observed especially the uneven role of advance in our social growth, and concluded by emphasizing the dangers of a policy of drift in the face of confusion and distress.

"Unless there can be more impressive integration of social skills and fusing of social purposes than is revealed by recent trends", said the committee, "there can be no assurance that the alternatives of force and violence, with their accompaniments of violent revolution, dark periods of serious repression of libertarian and democratic forms, the prescription and loss of many useful elements in the present productive system, can be averted."

"Fully realizing its mission, the committee does not wish to assume an attitude of alarmist irresponsibility, but on the other hand it would be highly negligent to gloss over the stark and bitter realities of the social situation and to ignore the imminent perils in further advance of our heavy technical machinery over crumbling roads and shaking bridges."

In the course of its findings, the committee recognized the importance of economic and other types of planning, but admitted that we are still in the stage of making plans for planning. It concluded its recommendations by suggesting the desirability of organizing a National Advisory Planning Board.

Since the publication of that report, events have moved rapidly and sharply in the dangerous direction of which the committee gave warning. In Germany and Austria the parliamentary and democratic balance of authority has been violently overthrown, and an entirely different system substituted. In the United States the financial crisis of 1933, with the closing of every bank in the land, with 13 millions of unemployed, and with the general prostration of industry and agriculture, brought the Nation face to face with stern realities. Prompt and bold action to prevent complete collapse was necessary, and was taken by President Roosevelt and Congress.

The series of measures, national and local, commonly characterized as the "New Deal", indicate, however, more vividly than ever before the importance of a deliberate study of our basic national policies as a whole and in their relations to one another.

I. American Planning

Planning is a distinctly American idea. The Constitutional Convention gave us our national plan of Government. Hamilton's "Plan of Manufactures", Jefferson's and Gallatin's "Internal Improvements", Clay's "American System", the American Homestead Policy, the Conservation Movement, and the "economic mobilization" of the World War are all examples of national planning. Business planning is similarly a distinctively American idea in the form of "scientific management" and "management engineering."

II. Present Types of Planning in the United States

A long series of planning agencies is already at work in the Federal service, and in State and city governments as well. In addition to such significant developments as the Bureau of the Budget and the Federal Employment Stabilization Board, there have sprung up, especially within the last year, an array of other instrumentalities for systematic consideration of one area or another of Federal activitity. The great financial crisis and the policies of the "New Deal" called for hasty improvisation of ways and means of action, and the inevitable consequence has been the rise of a number of unrelated planning agencies put together as speedily as possible in order to meet the urgency of the situation. The striking feature in Federal activity is not the

[1] Abbreviated and revised from Report of National Planning Board, June 1934

absence of planning, but the number, variety, and profusion of plan and their lack of adequate coordination.

Some of the many planning agencies follow departmental lines rather carefully; others follow such topical classifications as water, land, minerals, forests, power; others follow geographical and jurisdictional lines, such as Federal, State, local, and regional.

The most recent additions to this group of planning activities are the Economic Security Committee and the study on taxation now in progress in the Treasury.

The detailed description of all these agencies, or even their charting, would be laborious and confusing, and could serve no other purpose than that of illustrating the importance of closer coordination in types of planning.[2]

Business Planning: This emphasis upon planning by public agencies should not obscure the fact that, at least in modern times, business has been the stronghold of economic planning, and the "center of diffusion" from which that practice has spread to activities organized in governmental units on the one hand, and in family units on the other hand. Accounting provides an admirable method of ordering complicated activities insofar as the values can be expressed in dollars. Aided by this technique, the business man has become the world's most systematic and inveterate planner. His incentive is supposed to be pure self-interest, but it is self-interest enlightened by the teachings of experience. He learns to count costs, to look ahead, to provide against contingencies. As his opportunities have grown larger, his technique has improved and the scope of his planning has expanded. Dr. Frederick W. Taylor's pregnant scheme of "scientific management", enlarged by the work of Gantt, Emerson, and others, is becoming a widely inclusive art of "management engineering" that calls for continual reviews of current practice and adjustments to meet anticipated conditions. Many of the inventions of today, whether of mechanical devices or of products, or of business methods, are "made to order" by the research departments of business enterprises. Upon market research, industrial research, and even upon "pure science", American corporations spend huge sums annually. Their financial and legal departments, also, are planning organizations in large measure. Trained specialists are in charge of buying, maintenance, production and marketing, so that every detail of the business may be directed with skill. As a nation, indeed, we put far more of our intelligence into business planning than into household or government planning. The harder the times the more business planning we do. The difficulty of meeting budget requirements and the necessity of paying high taxes are sharp spurs to efficiency.

In view of these patent facts, it is not surprising that many citizens believe that almost if not all of our economic planning should be left to business enterprises—the most skillful and the most interested exponents of the art. The public interest, it is argued, is safeguarded, provided that free competition is maintained. But practical experience has demonstrated that, great as are its contributions to social welfare, business planning has certain inherent limitations that are making it more and more necessary to improve planning in household management on the one side and planning in government activities on the other.

(1) Business planning can secure effective coordination of effort only within the limits of each independent business enterprise; that is, each group of business activities subject to a single financial control. It cannot effectively coordinate the activities of independent enterprises. "Coordination within an enterprise is the result of careful planning by experts; coordination among independent enterprises cannot be said to be planned at all—rather it is the unplanned result of natural selection in a struggle for business survival. Coordination within an enterprise has a definite aim—the making of profits; coordination among independent enterprises is limited by the conflicting aims of the several units. Coordination within an enterprise is maintained by a single authority possessed of power to carry its plans into effect; coordination among independent enterprises depends on many different authorities which have no power to enforce a common program, except so far as one can persuade or coerce others. As a result of these conditions, coordination within an enterprise is characterized by economy of effort, coordination among independent enterprises by waste".[3]

(2) The planning of business enterprises aims at making money. If the ultimate test of economic efficiency is that of satisfying the most important social needs in the most economical manner, then business planning must be warped by inequality in the distribution of income. Where a few have money enough to gratify almost any whim and where many cannot buy things required to maintain their efficiency or to give proper training to their children, it can hardly be argued that the goods which pay best are the goods most needed.

(3) From the viewpoint of business itself, planning to make money is a precarious undertaking that often ends in heavy losses or financial ruin. To enlarge upon the hazards of business enterprise in the modern world is superfluous. However skillfully the internal affairs of a corporation are managed, the whole venture may be wrecked by circumstances beyond the control and even beyond the knowledge of the managers. As markets grow wider, investments heavier and financial interrelationships more complicated, it becomes harder

[2] See Digest of National Planning in the United States Today. Report of National Planning Board, June 1934

[3] See Wesley C. Mitchell, "Business Cycles: The Problem and Its Setting," National Bureau of Economic Research, New York, 1927, p. 172.

for the ablest management to anticipate the conditions which the next few years will bring forth. The movement toward business combinations is largely a business man's remedy for uncertainty—his effort to extend the number of factors which he can control. All business is hazardous and the wise business man is always trying to diminish the risks by combinations or otherwise. But combination by one group of enterprises increases the hazards for other enterprises. It is not surprising that with growing frequency business men have turned to the Government for aid and demanded that it protect them against hazards which they cannot control, including the hazard of combinations among other business men. Many of the plans for legislation or administrative action to rectify or stabilize business conditions come from business men themselves. The extension of economic planning by the Government is becoming a more urgent business need as the scale and the complexity of business plans grow greater. Protests against "too much government in business" are no more familiar than demands from business that government assume burdens that private enterprises cannot carry

(4) The frequent recurrence of economic crises and depressions is acknowledged evidence that the automatic functioning of our business system is defective. In view of recent events no one longer holds that the business cycle is being ironed out. Instead, it appears that the difficulty of maintaining the necessary equilibrium among different factors in the enormously complicated mechanism is becoming greater rather than less. Aside from the widening of markets and the growth of combinations mentioned above, we face the fact that an increasing part of the annual output consists of semidurable goods which people can stop buying for a time if times are bad. The trend of population from farms to cities, and the diminishing dependence of farm families upon what they can make for their own consumption, their increasing dependence upon selling farm produce to get the wherewithal for buying other goods, mean that general economic maladies afflict more people more seriously than they did in past generations. Business planning has found no effective means of preventing the growth of these factors that tend to make the business-cycle hazard more serious. Rather, the hazard grows graver in large part because of business planning.

(5) As Secretary Wallace has pointed out, recovery from grave economic depressions is being retarded by the divergent policies followed by corporations in highly organized industries and the policies forced upon farmers and other producers. Formerly, when demand for products declined, prices fell in almost all markets and output was checked. As a result, existing stocks of commodities were reduced rather rapidly, costs of production declined with the price of raw materials, and it soon became possible to resume production on an increasing scale with a good prospect of making profits. Balance was restored through the automatic operations of markets which no producer could control. In recent decades this "natural" process of recovery has become less and less effective. Great corporations often find it possible and advantageous to maintain prices during depressions and to cease production. But if farmers are to live they must continue to produce and to sell for whatever price they can get. Then the low-price group cannot buy what they need from the high-price group, and the latter have small inducement to enlarge their output. Recovery under such conditions is a far slower and more halting process than when all prices were flexible in much the same degree.[4]

It thus appears that there is need for Government economic planning, not to replace business planning, but to render services to the general public and to business itself, which business cannot render. Business cannot satisfy the wants of people who are unable to pay prices that are profitable in the long run, however pressing and important these wants are. Business cannot master the troubles it produces for itself by the widening of markets and the spread of combinations. Business cannot protect itself effectively against the business-cycle hazard. Business cannot maintain equilibrium when the automatic mechanism of markets in which all prices are flexible has been thrown out of gear by the development of a large group of inflexible prices. When the Government attempts planning in these fields it is attacking problems of enormous difficulty with which men can learn to deal effectively only by careful analysis and well-designed experiment. But in trying to find solutions for these problems the Government would not be making inexpert attempts to do what business accomplishes. So far as government succeeded in finding solutions, it would be broadening and making safer the field of private enterprise.

Coordinated Planning: The weakness of our American planning in the past has been the failure to bring the various plans and planners, public and private, into some form of concert with one another, to develop public interest planning in concert with planning in the private interest. The plans of business, the plans of labor, the plans of agriculture, the plans of science and technology, the plans of social welfare, the plans of government, have not heretofore been aligned in such manner as to promote the general welfare in the highest degree attainable. Much of the unbalance, insecurity, and suffering which our country has experienced in the past might be avoided in future by a more perfect coordination of the knowledge which we already possess.

Much remains to be achieved in bringing together a complete and rounded view of important planning programs actually in progress, and in avoiding the adoption of plans which are incompatible with each other, by the construction of designs for more skillful adaptation of

[4] See Henry A. Wallace, "New Frontiers", New York, 1934.

different programs to each other and to the national interest. Unless vigorous and intelligent action is taken there is grave danger of heavy loss from the lack of planning among the planners themselves.

First of all, beginning with the local jurisdictions, the plans of cities, counties, and States may well be brought together far more closely in a better form of relationship. Doubtless the State planning boards which have recently come into being will do much to improve the situation at this point. Next, the plans of the several States have little relation to each other, even though their problems may often be found in common, as in the case of highways. Further, the plans of the Federal Government and those of States and cities are developed independently of one another in large measure and without regard to any unity or consistency of program.

At the same time various types of governmental planning must be related to industrial planning, to semipublic planning, to the types of planning developed by technical and professional groups.

III What is Involved in Planning?

Planning consists in the systematic, continuous, forward-looking application of the best intelligence available to programs of common affairs in the public field, as it does to private affairs in the domain of individual activity. In every well-directed home, in every business, in every labor or agricultural group, in every forward-looking organization, social planning goes on continuously, and in the world of government is no exception.

Several considerations are important in looking at plans for planning:

(1) The necessity and value of coordinating our national and local policies, instead of allowing them to drift apart, or pull against each other, with disastrous effect.

(2) The value of looking forward in national life, in advance rather than afterward, of preventing the fire rather than putting it out.

(3) The value of basing plans upon the most competent collection and analysis of the facts.

In any case, not all planning is or should be national planning. There is local and State planning, and planning by quasi-public and private agencies and institutions all over the land. The city planning boards thus far chiefly concerned with physical plans and the State planning boards just beginning their work, to say nothing of scores of industrial and other organizations, will continue to develop their special points of view. The centralization of all planning in Washington is not contemplated, and even if possible would not be desirable, since planning is an attitude and practice that must command the confidence and cooperation of wide groups of people to ensure successful operation, must come from the bottom up as well as from the top down, from the circumference as well as the center.

It may reasonably be anticipated that many of the most useful suggestions regarding types of planning will emerge from jurisdictions outside the Federal Government, and outside the governmental group altogether, from detached individuals and associations of individuals, industrial, scientific, or otherwise.

Planning then does not involve the preparation of a comprehensive blueprint of human activity to be clamped down like a steel frame on the soft flesh of the community, by the United States Government or by any government.

Second, planning does not involve setting up a fixed and unchangeable system but, on the contrary, contemplates readjustment and revision, as new situations and problems emerge. Planning is a continuous process, and necessitates the constant reexamination of trends, tendencies, policies, in order to adapt and adjust governmental policies with the least possible friction and loss. The national life is like a moving wave in which a new equilibrium must constantly be found as it sweeps forward. Even physical planning is subject to continuing revision as new factors such as the motor vehicle appear to supersede old ways, while planning, in the broader sense of the term, is likewise subject to change as new inventors come in to disturb older calculations.

Stubborn adherence to an outworn plan is not a mark of intelligence but stupidity, whether in the life of individuals or of nations. Prudence would, of course, dictate that reasonable stability should not be endangered by capricious or arbitrary shift of plans, but would with equal force insist that policies must be promptly modified as emerging trends and new situations necessitate recasting.

Third, it is false and misleading to assert that all planning involves wholesale regimentation of private life. Sound planning on the contrary brings about a fresh release of opportunities rather than a narrowing of choice. Street planning and traffic regulation operate for freer use of the highways than unplanned streets and uncontrolled traffic. Laws regulating unfair trade practices release the energies of fair-minded men for other activities than that of guarding against fraud and trickery.

It cannot be forgotten that regimentation is a brutal fact in many private industries now. The modern type of nation was set up in order to break down the old private or semiprivate tyranny over roads, justice, taxation, and to establish public and national control over robber-baron situations that became unendurable. An individual business man may be absolutely regimented by a ruthless monopoly, just as an individual worker would be helpless against terms dictated by an employer. Over and over again in the United States, as elsewhere, the community has been obliged to intervene to protect the weaker against the insolence and oppression of private citizens who perpetrated injustice and outrage upon their weaker brethren.

Indeed it may be found that some of those who cry "regimentation" when public planning is mentioned foresee interference with their own practices of private regimentation and exploitation of otherwise helpless persons under their private control. Those with special privileges to protect and preserve naturally object to any public planning that may dislodge them from a preferred position where they are able to exact tribute from their fellow men. This is by no means the only type of opposition to planning, but it is one to which attention must from time to time be directed, since it arises from a type of exploitation from which explosive reaction is most likely to result.

The truth is that it is not necessary or desirable that a central system of planning actually cover all lines of activity or forms of behavior. Such planning overreaches itself. Over-centralized planning must soon begin to plan its own decentralization, for good management is local self-government under a centralized supervision. Thus wise planning provides for the encouragement of local and personal initiative, realizing that progress may as easily be smothered by overcentralization as by its opposite. Not all government can ever be central government, or all life public life. Experience shows that there must be wide ranges of affairs in which independent criticism, independent judgment, independent initiative is given opportunity for free growth and development in associations as in individuals. One of the recurring tasks of statesmanship is to cultivate and encourage decentralization. In the excited discussion over this subject, it is often forgotten by both sides that genuine planning really includes planning to preserve and even create noncontrolled free areas of activity. Planning is not an end, but a means, a means for better use of what we have, a means for emancipation of millions of personalities now fettered, for the enrichment of human life in ways that will follow individual interest or even caprice. We may plan indeed for fuller liberty and are so planning now.

When men express sincere opposition to all governmental planning, it can only mean a grave misunderstanding of what planning really is, or an opposition to some special detail of planning that seems undesirable, rather than to the general principle.

Wise planning is based on control of certain strategic points in a working system—those points necessary to ensure order, justice, general welfare. It involves continuing reorganization of this system of control points from time to time. The number of controls is never as important as their strategic relations to the operation of the society in which they work. At various times, the community has found it necessary to deal with landowners, with slavery, with the church, with the army, with industrial or labor captains, with racial groups, adjusting control points to meet special situations, and restricting some privileges at one point while releasing other forces and individuals at other points.

It is this shift in the form of planning, the change in strategic planning points, as social and economic conditions change, that leads some to the erroneous conclusion that we have never planned before in America, when in point of fact our planning has been continuous and varied as conditions varied.

The essence of successful planning is to find these strategic points as new situations develop, without too great delay, and without seizing more points than are necessary for the purpose—or for longer time than is necessary for the purpose. Insight, sagacity, inventiveness, cooperative spirit, are far more important at this point than the club.

Some of these strategic planning points developed in the history of this Nation have already been mentioned. In more recent times, national attention has been directed toward land and water utilization, conservation of natural resources, flood control, regulation of public utilities, unfair trade practices; still more recently to the banking and financial structure of the Nation, to industrial insecurity, both on the part of worker and investor, to unemployment, to social insurance and welfare problems, to un-American living standards—these among a wide variety of emerging issues of national significance.

In the organization of planning undertakings, the cooperation of the natural and social sciences is of the highest importance. The highest scientific talent of the Nation would be available for the purpose of systematic national planning and the Government could count upon the cordial and unremitting cooperation of impressive agencies of investigation and exploration already organized to render effective service such as the American Academy of Science and the Social Science Research Council. The guaranty of such assistance is of deep importance in considering the possibilities of planning. In the natural science field arise many of the inventions and technologies which while increasing our possibilities for weal, also make possible much woe if they are not fortunately set in the framework of the social and economic structure. The cooperation of scientists in this field should make possible a wiser and sounder adaptation of technology to economic and social advancement. The cooperation of the social scientists with their research in the field of human behavior should correspondingly facilitate the making and perfecting of social inventions, keeping pace with those in natural science. The memoranda presented by those organizations are impressive in nature and full of promise for technical cooperation in the national planning of the future. In the previous chapter of this report attention is given to the basic data indispensable for the purpose of scientific mapping and planning.

It cannot be too strongly stated that we do not approach the planning of natural and other American resources in any spirit of defeatism. The present emergency may have hastened the growth of systematic planning, but the careful inventory and appraisal of our resources, and the consideration of how we may most effectively utilize these resources, could not in any case have been long delayed, after our frontier had been closed and the progress of mechanical invention established as a permanent factor in our civilization.

We do not stand at the broken end of a worn-out road, but look forward down a broad way to another era of American opportunity. Among the nations of the world, America has stood and still stands for discovery, for pioneering across a great continent, for fearless experiment in directions where others had failed, for achievement in mechanism and management, for ready adaptation to new conditions and easy adjustment to new ways of life. When we are resigned to drifting and too weary to plan our own American destiny, then stronger hands and stouter hearts will take up the flag of progress and lead the way out of difficulties into attainment.

IV. Organization and Functions of a Permanent Planning Board

In view of the facts set forth in the report of the National Planning Board, the National Resources Board recommends that the Federal Government create a permanent national planning board, directly responsible to the country's Chief Executive. The function of the proposed board would not be to supplant the numerous planning agencies now active in various departments of the Federal Government or elsewhere but to supplement their work and to promote closer coordination among the plans they severally prepare for submission to the President.

The necessity of consultation with labor, agriculture, and industry and the presentation of their respective points of view at all stages of the planning process has already been stressed. It is to be assumed that these points of view will be presented to a national planning board. Effective technical planning must be related to social directives. The interests of all groups can be furthered only if there is intimate experience of the needs to be served.

The outlines of the structure, activities, procedure, and relations of such a permanent national planning board are indicated in the following paragraphs:

(1) Organization:

It is recommended that a national planning board be set up consisting of not more than five members, appointed by the President of the United States; and, in addition, a rotating panel of consultants, appointed by the board. Responsibility for board action would rest with the five members, and the panel would constitute an advisory group with a voice but not a vote in the findings and recommendations of the board.

It is recommended that the term of the board members be made indefinite, as in the case of the present Civil Service Commission. A long term of office is no adequate protection against an unfriendly or indifferent Executive and Congress; and in any case a deadlock between the board and the authorities would make the success of the board very dubious. A board may be swept out of existence by Congress at any time, or it may be ignored by the Executive and the administration.

On the other hand, the indeterminate tenure does not lead to the removal of board members without some excellent reasons as readily as a fixed term; for the arbitrary removal of men commanding the public confidence and respect would not tend to strengthen the Executive with the Nation.

Life tenure of office for such a board, even if it were possible to obtain it, would not be desirable; for it would tend to widen gaps between the Government and the board, or between the public and the board. In a rapidly changing situation such as is involved in modern planning, the fossilization of a board of this type would be disastrous

Continuity in the personnel of such a board is useful as a means of preserving and utilizing the accumulating knowledge and experience of its members, and there is nothing to prevent the realization of such advantages in the proposed arrangement. On the other hand, it is indispensable that such a board of strategy command the confidence of the Chief Executive of the Nation, if it is to function in any other than a perfunctory manner. Even the most competent board, however well fortified in a statutory position, could accomplish little in the face of indifference or hostility on the part of the responsible governing officials.

It is recommended that the compensation of the board be fixed at an amount consistent with the importance of the service rendered, and sufficient to make it possible to obtain the services of the high type of competence necessary for such a branch of public service. It is recommended that the panel of consultants be paid at a per diem of $25, with a minimum annual retainer. It is important that these competent and carefully selected persons be interested in the planning service, so that national planning may be considered from many points of view, and that planning be made a cooperative undertaking in which ideas and suggestions flow freely into as well as out from the center.

The personnel of the board should bring together insight, experience, and judgment in the analysis and interpretation of national planning policies, skill in the invention of ways and means of utilizing the national resources in material and men, and social vision in the fusion of American interests, techniques, and ideals into sounder and more satisfactory national policies.

The guaranty of the selection and the continuity of persons equal to such responsibilities must be found in the judgment of the President of the United States.

Such a rotating panel may well include men or women from various groups able to contribute to national planning—as governmental bureaus, labor, agriculture, industry, the home, technical and scientific societies, and other groups directly concerned with the sound formulation of the lines of our national progress.

While not responsible for board conclusions and action, or for collective research, their advice and council would be of high value in the organization of inquiries, in the analysis and interpretation of data assembled, and in the interrelation of technical conclusions to national spirit and ideals

It is recommended that there be a director appointed by the board, in general charge of the staff, and a secretary of the board; and that the further organization of sections and divisions of the work be left to the determination of the board.

It is further recommended that the board prepare and present to the President an annual report setting forth and summarizing the work of the board during the preceding year.

It would be necessary to have ample provision for the maintenance of a staff, equal to the performance of the heavy tasks imposed upon it. If national planning is really of substantial importance and value to the Nation, as we believe, it goes without saying that generous support of such an undertaking is indispensable. In general, the staff of such a board as is proposed would consist of:

(*a*) A permanent skeleton staff of men of undoubted competence with their assistants, possibly organized as a secretariat to a series of committees somewhat like the present technical committee of the National Resources Board.

(*b*) Government personnel with special skills detailed from time to time for the work of the board.

(*c*) Experts and assistants brought in from time to time to deal with special problems as they arise. A free fund for this purpose should be available, but inevitably the amounts required would vary widely from one period to another, as different types of assistance were required.

In addition to this, the board should be in close touch with a great variety of agencies engaged in research pertinent to the problem of planning. Among those are the universities and research institutions, the occupational groups, business, labor, agriculture, the professions interested in special lines of inquiry, and the planning and research agencies of other governmental jurisdictions, State and local or regional. A vast amount of material is available from these sources, and a skillful board with the requisite qualities of leadership and with a gift of cooperation would be able to utilize the research and planning program of other groups for national purposes.

(2) Functions:

The Board and its staff would serve as a clearing house for significant plans of many types developed in Federal, State, or local service—by public or private or quasi-public agencies. Appropriate powers of fact-finding and facilities for plan analysis would be granted to the Board. At present no such national agency exists and there is often serious difficulty in obtaining the necessary data regarding important plans or projects in actual operation among 175,000 governmental bodies and many other quasi-public groups, industrial, research or otherwise.

A mere card catalog of all projects would be of little value for this purpose, but an intelligent understanding of the main lines and types of planning research would be of high value, not only for those engaged in such tasks but to governing officials charged with the final duty of formulating and administering policies.

The Board would have the function of tendering its friendly offices as a coordinator of various Federal plans, and of Federal and State or local plans, or other types of plans where closer cooperation might seem desirable and feasible. For this purpose conferences and consultations would be useful through individuals and through continuing committees for the analysis of conflicting or unrelated plans, and towards constructive efforts to bring into closer harmony broad plans of action not adequately organized with reference to each other.

The coordinating activities of the Board would lie in several overlapping fields of which two may be cited.

(1) Functional coordination such as that recommended by the water resources section in part I of this report and exemplified in the work of the water planning committee.

(2) Geographical or jurisdictional coordination as between local, State, regional and Federal planning agencies. In a two dimensional figure of this sort it is obviously impossible to put any one activity under a single heading, and groups or committees set up to further coordination in general must function to some extent in other fields.

Planning agencies have already been developed in a number of Cabinet and other Federal offices, and it is to be anticipated that more will be set up. Since the division of functions among the several departments is a result of historical growth rather than of planning, "departmental planning" may run counter to "functional" planning. This same difficulty exists in Bureau organization but to such a small extent as to be practically negligible. The establishment of interbureau or other planning divisions would contribute greatly to the sound development of national planning. A

national board and its staff would encourage and welcome such agencies where they are not now found, cooperate with those in active operation, endeavor to bring together lines of planning that seemed to run too far apart or even unwittingly at variance with each other, and in general use its good offices to bring about the best understanding among planners, and the highest and best use of all such research agencies for the common national welfare as seen in the domain of planning. In this field it may be observed in passing that the intelligence and vision of a board and its staff, the respect and confidence they enjoy among groups whose intimate cooperation is indispensable, will be far more effective than statutory powers or bristling governmental sanctions.

The various planning activities going on within departments will continue on an even greater scale than heretofore. The Government bureaus will always be planning in their special fields. Further there are many questions which cut across the boundaries of established departments as in the case of land, water, and mineral resources which are discussed in the text of this report. In such cases the necessary planning requires cooperation and the very existence of a central planning agency facilitates cooperation in many ways.

But every Cabinet member is the head of a huge going concern which he must administer and for which he is responsible. Cabinet members are overburdened with a bewildering variety of administrative duties and are confronted with an overwhelming mass of decisions which cannot be postponed. They are also drawn into the discussion of urgent national problems upon which action is imminent, and in which their relations to the President, to Congress, and to the public are such as to entail upon them the heaviest and gravest responsibilities.

In the sense of having ultimate political and administrative responsibility, the Cabinet members are themselves a final planning council acting with the President and the Congress; but in the technical sense they may advantageously be served and strengthened by an agency more detached from the stress of daily commitments and obligations. A technical general staff has already been found useful both in public and in private business, and might well be adapted to national governmental purposes.

It is equally important that attention be directed to the planning enterprises and studies under way in various quasi-public enterprises and institutions, and to the desirability of relating those different plans to each other more rationally.

Some of the possibilities in coordinated planning of all three types—administrative, functional, and jurisdictional—have been explored during the last year by the National Planning Board and the National Resources Board. Through the land-planning committee with representatives from Agriculture and Interior, interdepartmental coordination in land-use studies has been pushed forward. Through the Mississippi Valley committee and the water planning committee a functional approach to planning has been developed; and through the Board's interest in State planning new coordination of State and Federal programs has been facilitated.

The flexibility and economy of these types of planning organization have been proven through the efforts of the last 2 months to prepare the land, water, and mineral reports contained within these covers. With a small central staff, necessary funds, and the hearty cooperation of numerous Federal, State, and private agencies, needed basic data and policy recommendations can be developed with speed, economy, and assurance.

One of the duties imposed upon the previous National Planning Board, and now on the National Resources Board, is that of encouraging and stimulating interest in various forms of planning—State, local, and regional. Judging from the experience of the last year, this is a field of very lively and keen interest. Over 40 State planning boards sprang into existence almost as if merely awaiting the suggestion. Regional planning agencies were likewise developed with great enthusiasm, while the work of city boards was rejuvenated, especially during the period of assistance afforded by the generosity of the Civil Works Administration. It is clear that there is a wide range of necessary activity in the interchange of information and experience regarding planning systems, and in assisting groups anxious to undertake planning in the most effective manner.

Decentralization of planning activity is essential to the healthy growth of those local and individual interests upon which public support and understanding rests. It is also essential in the development of the planning movement to develop responsibility in State and local officials and to find new leaders and enthusiasts.

It would further be the function of the board to initiate independent lines of inquiry into various aspects of a national program, contemplating the wisest use of our national resources, and to present the results of its work to the President with such findings and recommendations or alternative recommendations as may be indicated by comprehensive research and mature reflection; and for such use as the responsible governing agencies of the Nation might deem appropriate under all the circumstances. A discussion of some possible types of inquiry is found in earlier paragraphs of this report.

If successful, such efforts should make it possible to apprehend more clearly and promptly the emerging trends and problems of the Nation, and should contribute to the formulation of sound national policies adapted to the technological, economics and social changes in the American life.

It cannot be too strongly emphasized that the function of such a board as proposed is not that of making

final decisions upon broad questions of national policy—a responsibility which rests firmly upon the elected representatives of the people of the United States. Such a board would be useful in proportion as it was detached from immediate political power and responsibility, as a general staff gathering and analyzing facts, observing the interrelation and administration of broad policies, proposing from time to time alternative lines of national procedure, based upon thorough inquiry and mature consideration, constantly preparing and presenting to the authorities its impressions, findings, conclusions, recommendations for such disposition as those entrusted with governmental responsibility may deem appropriate. How keenly such a board might observe what is happening, how wisely it might judge, how intelligently it might invent, how shrewdly it might interpret the national interests and values—such considerations would in the long run determine its usefulness and permanence.

The role of a national planning board in American life might become of great importance and value in helping to find the difficult way toward the realization of that union of popular control in Government and wide-spread diffusion of welfare and well-being which has been the promise of American life, not yet attained but constantly the goal of undaunted American endeavor.

Such a board if composed of men gifted with the rare qualities necessary for such high enterprise, amply supported by indispensable staff and equipment, might well prove an important factor in the difficult period of transition through which we pass—a period in which there is reason to believe that change will be more rapid than ever before in human history, that social adjustment will be more urgent than ever before. But by the same logic, a period in which the possibilities of human advancement are greater than ever before.

A planning board might facilitate the interchange of experience and information regarding a wide variety of planning devices in many lines and on many levels; it might help to bring together planners and their plans, lest they drift apart or fall afoul of each other; it mighreach out in pioneering spirit and explore new possibilit ties or suggest new devices by which America might advance more swiftly and surely.

Standing apart from political and administrative power and responsibility, but in close touch with the chief executive and under the control of the political powers that be, such a group of men would have large opportunity for collecting the basic facts and for mature reflection upon national trends, emerging problems and possibilities, and might well contribute to those in responsible control, facts, interpretations and suggestions of far-reaching significance.

It is easy to underestimate the possibilities of the wise use of a competent general staff for our Government in peace as well as in war.

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ACKNOWLEDGMENTS

The preparation of this report in the short space of five months has been possible only because of the cooperation and previous knowledge of many individuals and organizations. The advisory committee has been responsible for the organization of the foregoing material—the Board's report—on which special help was received from Dr. L. C. Gray, Mr. Morris L. Cooke, Dr. F. G. Tryon, Maj. Philip B. Fleming, Mr. John Bennett, Mr. W. P. Rawles, Mr. Horace W. Peaslee, and the executive officer. As already noted, the report is based on intensive investigations by various committees and by the former National Planning Board.

The staff of the Board, under Mr. Charles W. Eliot 2d, executive officer, has been organized in sections with several units of the Land Section working directly in the offices of cooperating bureaus. The necessity for rapid selection and appointment of the staff, both in Washington and in the field, placed a heavy burden upon Mr. E. K. Burlew and the Office of the Secretary of the Interior, as well as on the central office of the Board. Long hours of overtime work have been volunteered by members of the staff in all units.

The presentation of this report in printed form has been made possible through the cooperation of the Public Printer and his office with Mr. Lloyd George and his associates from the staff of the Board.

The section on mapping—part V—has been prepared by the Board of Surveys and Maps and the Science Advisory Board has been consulted in regard to it. Each of the remaining parts of this volume prepared by the special committees on land, water, and minerals include acknowledgments to the several contributors involved.

PART II
REPORT OF THE LAND PLANNING COMMITTEE

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LETTER OF TRANSMITTAL

NOVEMBER 15, 1934.

To the National Resources Board:

Your Land Planning Committee submits the attached report on land utilization and policy prepared under the direction of Dr. L. C. Gray, in collaboration with various Federal and State agencies and with the assistance also of a special staff provided by funds made available by the Board.

This committee has carefully reviewed the report and has made numerous suggestions which have been incorporated.

A much larger body of valuable and more detailed material, including a number of newly made maps not comprised herein, has been assembled as a basis for this summary. This is the most comprehensive body of material ever assembled in this country on this subject. If provision could be made for its publication later, it would be of great service to the numerous persons and agencies concerned with land investigation, planning, and administration throughout the country.

The Land Planning Committee:

M. L. Wilson, chairman; L. C. Gray, director; Mordecai Ezekiel; Charles W. Eliot, 2d; Oscar Chapman; W. G. Mendenhall; H. H. Bennett; and Jacob Baker.

PART II
INTRODUCTION

This summary report on land utilization and policy covers broadly the principal problems of surface uses of the land. It takes stock of the present and probable future requirements for various products of the land, and inventories the available land resources which may be used to satisfy these requirements. It points out maladjustments in present land uses and advocates public policies for correcting such maladjustments.

This summarized report is a condensation of a much larger report, including many valuable maps, charts, and tabulations not included herein, which it is recommended be published, since it represents the most comprehensive body of information on land utilization and policy which has yet been brought together in this country.

With only 5 months available for preparation and publication of the report, detailed field surveys for the collection of data have not been possible, and it has been necessary to depend largely upon data already available in Washington and at State agricultural colleges and other State institutions, supplemented by hasty reconnaissance field surveys.

The report was prepared under the direction of Dr. L. C. Gray, director of the land section of the technical committee of the National Resources Board, aided by John B. Bennett, who served as administrative assistant. The Resources Board provided a temporary field staff consisting of 48 State land-planning consultants, 10 regional land-planning consultants, and a force of clerical assistants to these consultants. The land-planning consultants collaborated with and were assisted by the regional directors of the Land Policy Section of the Agricultural Adjustment Administration.

The following agencies of the Federal Government contributed to the report: The Geological Survey, the Soil Erosion Service, the National Park Service, the Office of Indian Affairs, and the Bureau of Reclamation, in the Department of the Interior; and the Bureau of Agricultural Economics, the Bureau of Agritural Engineering, the Bureau of Biological Survey, the Bureau of Chemistry and Soils, the Forest Service, the Weather Bureau, and the Program Planning Division of the Agricultural Adjustment Administration, in the Department of Agriculture. The National Resources Board furnished the extra technical and clerical assistance needed by these organizations for work on the report, but in most instances a large share of the work was done by the regular staffs and on the regular funds of these organizations.

State agricultural colleges, experiment stations, extension services, planning boards, conservation departments, and other State institutions rendered material aid in preparation of the report, particularly to the reports of the State land-planning consultants upon which certain recommendations on readjustments in agricultural land are based.

It must be recognized that the report as submitted is not merely a compilation of facts and recommendations prepared by individual Government bureaus. The Technical Land Planning Committee of the National Resources Board considerably revised many of the recommendations of some of these bureaus, so that the report does not reflect necessarily the exact views of the Federal agencies administering land.

PART II—SECTION I
CONDITIONS AND TENDENCIES INFLUENCING MAJOR LAND REQUIREMENTS

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SECTION I

I. THE OUTLOOK FOR POPULATION*

The growth of population in the United States is probably unprecedented in the history of the world. The census of 1790 counted 3,929,000 people, and that of 1930 counted 122,775,000. The increase alone between 1920 and 1930—about 17,000,000—was almost as great as the total population of Canada and Australia at the present time. Since 1930 the population of the Nation has increased to about 127,000,000. The rapid increase of population stimulated the swift development of industry, the extraordinary progress of commerce and transportation, and the great expansion of agriculture which occurred in the United States prior to 1930, and thus promoted the increase of land values. The expectation of a continuing rapid increase in population has long constituted an essential element in our national calculations and policies. During the past decade a great change has occurred in the outlook for population growth which has profound implications for land utilization and policy.

The Decline in Births

During most of the Nation's history the birthrate has been high. Prior to the Civil War population doubled every quarter century. The birthrate began to decline, however, as early as 1820, and it has been declining almost constantly since (see fig. 2), although the number of births continued to increase until 1921. (See fig. 1, top line.) This was because the birthrate, though diminishing, did not decline fast enough to offset the effects of the increase in the number of women of childbearing age.

Since 1921 the number of births as well as the birthrate has been declining. During the years of urban prosperity, 1922–29, the decline in births averaged

* The following persons have contributed to the preparation of this chapter: O. E. Baker and Nettie P. Bradshaw, Division of Land Economics, Bureau of Agricultural Economics; and Warren Thompson and J. B. Dennison, Scripps Foundation for Research in Population Problems (the services of Dr. Thompson and Dr. Dennison were provided by the National Resources Board). This and other sections of the report were edited by Esther Thompson, Land Policy Section, Agricultural Adjustment Administration, and Edith D. Dunston, Division of Land Economics, Bureau of Agricultural Economics. Illustrations for the agricultural land use sections were prepared largely by the Graphic Section and the Photographic Labratory of the Bureau of Agricultural Economics.

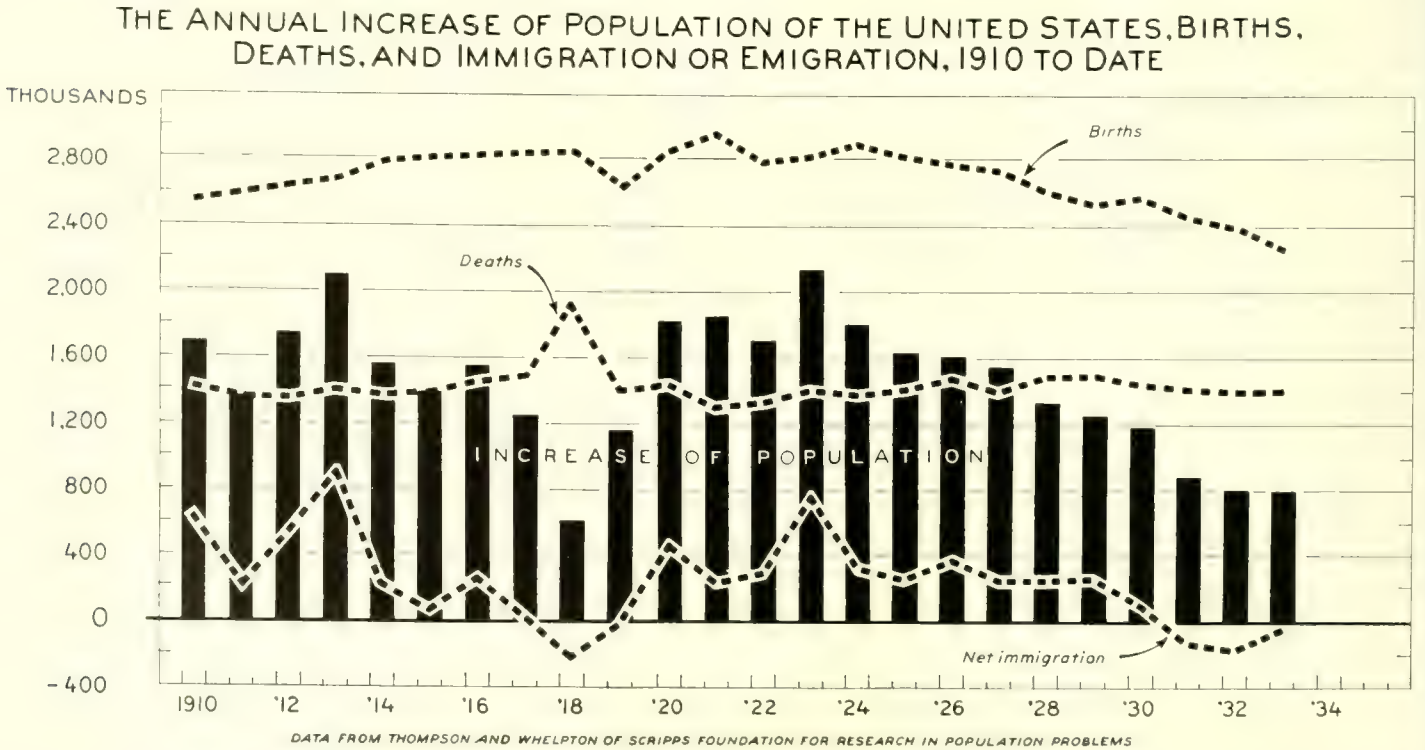


FIGURE 1.—Ten years ago the population of the United States was increasing about 1,800,000 a year. Now the increase is only 800,000. A stationary population is approaching rapidly. The number of births has been trending downward since 1921. There are now fully 11 percent fewer children under 5 years of age than when the census was taken nearly 5 years ago, and 9 percent fewer 5 to 10 years of age. The number of deaths remains almost stationary, but must increase soon, because of the rapid increase of old people.

about 50,000 a year. Since 1930 the decline has averaged 100,000 a year. In 1921 about 2,950,000 children were born in the Nation; in 1934 about 2,200,000. The enrollment in the lower grades of the public schools is already decreasing, and this decrease will soon be more rapid. This decline in children will be reflected in a decline in the number of possible mothers within the next 2 decades, and will result in a still further decline in the number of children, unless the birthrate rises, or the restrictions on immigration are relaxed.

Immigration

Under the quota law, in effect after July 1, 1924, the excess of arrivals in the United States over departures was close to 250,000 a year until 1929. (See fig. 1, lower line.) In 1930, owing to the depression and unemployment, it fell to about 100,000. In 1931 and 1932, as unemployment increased, and after administrative restrictions were placed on immigration, the net movement outward exceeded 100,000 each year. In 1933 there was a net emigration of 31,000. The safest assumption relative to immigration, so far as one can foresee, appears to be that emigrants will approximately balance immigrants. There is little indication of relaxation in restrictions on immigration; on the contrary, conditions point to continued restriction.

Factors Affecting the Birthrate

With reference to the birthrate, the prospect is for continued decline; the uncertainty is the rate of decline. In estimating this rate of decline several factors need to be considered:

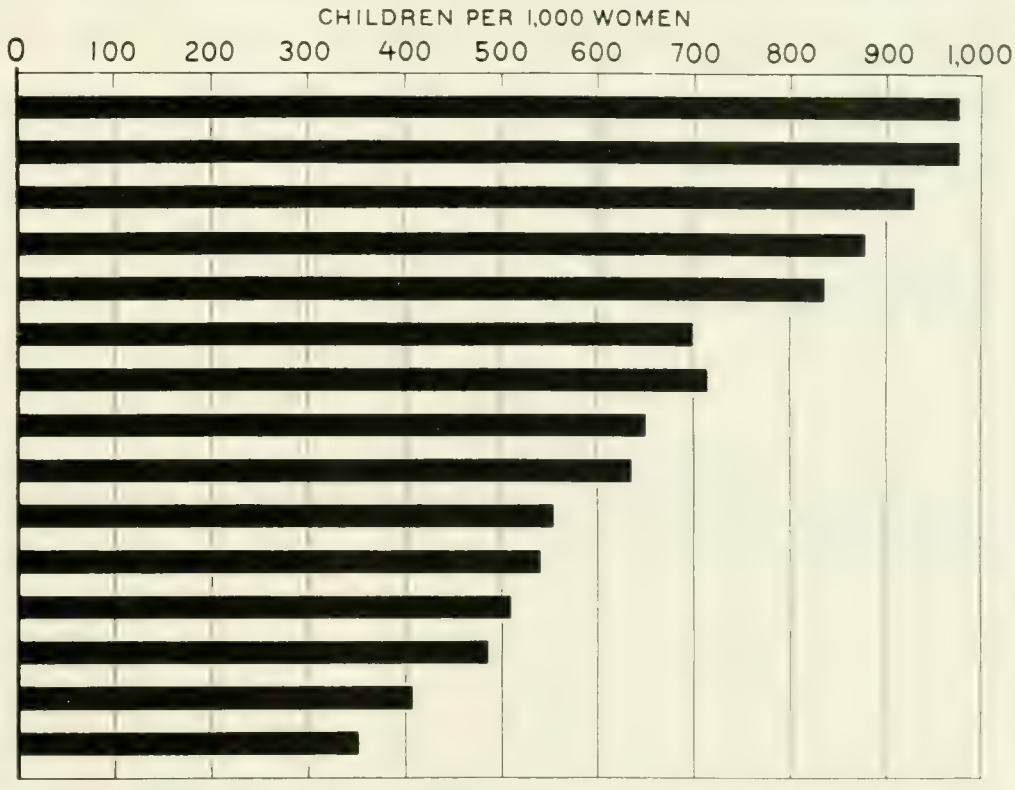
The Rural-Urban Factor: The birthrate is everywhere lower in the cities than in rural districts. In the United States the 1930 census revealed that the number of children under 5 years of age per 1,000 women 15 to 45 years of age was only about half as large in the cities of over 100,000 people as it was in the farm population. (See fig. 3.) The number of births in the large cities now lacks 30 to 35 percent of being sufficient to maintain their present population. In the farm population, on the other hand, there is a 40 to 50 percent surplus.

The Social Status Factor: In the United States the birthrate declines as the economic or social status of the family rises. There is some evidence, however, that families which have early attained economic security, either through inheritance of wealth or through personal efforts, have more children than families of less assured position.[1] But, in general, families of business men average 5 to 10 percent more children than those

[1] Lorimer, Frank, and Osborn, Frederick, *Dynamics of Population*. New York, 1934), pp. 88–92, 274–297, 376–379.

NUMBER OF CHILDREN UNDER 5 YEARS OF AGE PER 1,000 WOMEN 16 TO 44 YEARS OF AGE (INCLUSIVE) UNITED STATES, 1800-1930 AND ESTIMATE FOR 1934

YEAR ↓	NUMBER ↓	PERCENT CHANGE
1800	976*	
1810	976	0.0
1820	928	- 4.9
1830	877	- 5.5
1840	835	- 4.8
1850	699	-16.3
1860	714	+ 2.3
1870	649	- 9.1
1880	635	- 1.8
1890	554	-12.8
1900	541	- 2.4
1910	508	- 6.1
1920	486	- 4.3
1930	407	-16.3
1934	350^	-14.0



*ESTIMATES OF PROF. WALTER WILLCOX PRIOR TO 1880 SEE PUBLICATION AMERICAN STATISTICAL ASSOCIATION. VOLUME XII PAGE 495. BOSTON 1912
^CHILDREN-RATIO OF BIRTHS 1925-1929 TO CENSUS 1930, APPLIED TO BIRTHS 1929-1933

FIGURE 2.—The birthrate, as measured by the ratio of children under 5 to women of childbearing age, has been decreasing in the United States for more than a century. From 1920 to 1930 the decline was over twice as rapid as in previous decades, except those ending in 1850, 1870, and 1890, when it is evident there was an abnormal underenumeration of young children. From 1930 to 1934 the decline was almost as great as in any previous decade. The significant fact shown by the graph is that the decline is not a new one, but a long-time trend, and that the rate of decline has become more rapid in recent years.

of professional men, skilled laborers a quarter to a third more than business men, and unskilled laborers about a fourth more than skilled laborers.[2]

The Migration Factor: On account of the difference between rural and urban birthrates, migration between farm and city exerts an important influence on the national birthrate. It appears very likely that should prosperity return to the cities, a migration might develop from the rural areas approaching, perhaps exceeding temporarily, that during the period 1920–30. In addition to the current natural increase on farms of about a half million annually, there are now more than 3,000,000 people backed up on farms, including probably 2,000,000 people under 35 years of age, who, under predepression conditions, would have migrated to or remained in the cities. This is raising acute problems of rural adjustment, including land use and tenure considered in later portions of this report. Should the migration to cities again develop, the proportion of the Nation's population having a low birthrate would increase, and that having a relatively high birthrate would decrease. Moreover, city people have a higher death rate than rural people. The future growth of population in the United States is clearly bound up with the degree of concentration in the cities.

Assuming that cityward migration will be resumed, and that births in the Nation decrease 50,000 a year, as they did during the years 1921–29, and that no net immigration from abroad occurs, a maximum population of approximately 131,500,000 would be reached about 1947. Thereafter population would slowly decline. But if the depression persists, even though the rural-urban migration approximates a balance, the number of births may still decline very rapidly, judging from the record of the past 4 years. Apparently, the economic pressure of the depression has more than offset the influence of the increased proportion of the

[2] Notestein, Frank W., "The Decrease in Size of Families from 1890 to 1910", *Milbank Memorial Quarterly*, vol. IX, no. 4 (Oct. 1931), pp. 182–188; also "The Relation of Social Status to the Fertility of Native-born Married Women in the United States", a chapter in *Problems of Population* (London, 1932).

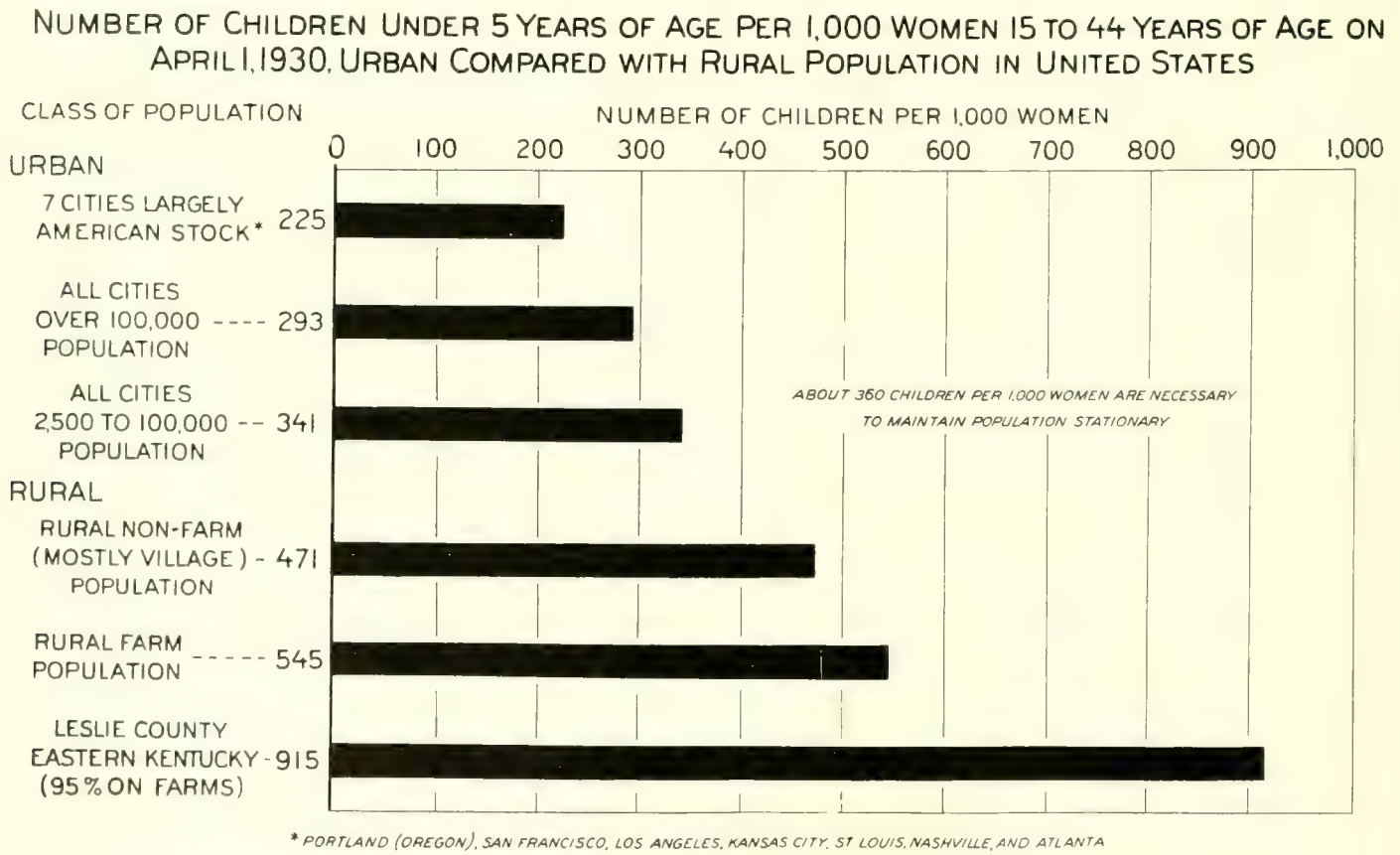

NUMBER OF CHILDREN UNDER 5 YEARS OF AGE PER 1,000 WOMEN 15 TO 44 YEARS OF AGE ON APRIL 1, 1930, URBAN COMPARED WITH RURAL POPULATION IN UNITED STATES
CLASS OF POPULATION
NUMBER OF CHILDREN PER 1,000 WOMEN
0
100
200
300
400
500
600
700
800
900
1,000
URBAN
7 CITIES LARGELY AMERICAN STOCK* 225
ALL CITIES OVER 100,000 POPULATION 293
ALL CITIES 2,500 TO 100,000 POPULATION 341
RURAL
RURAL NON-FARM (MOSTLY VILLAGE) POPULATION 471
RURAL FARM POPULATION 545
LESLIE COUNTY EASTERN KENTUCKY (95% ON FARMS) 915
ABOUT 360 CHILDREN PER 1,000 WOMEN ARE NECESSARY TO MAINTAIN POPULATION STATIONARY
* PORTLAND (OREGON), SAN FRANCISCO, LOS ANGELES, KANSAS CITY, ST LOUIS, NASHVILLE, AND ATLANTA

FIGURE 3.—About 360 children under 5 years of age per 1,000 women 15 to 45 years of age (childbearing age) are required to maintain population stationary at the 1930 expectation of life in the United States of 62 years. In 1930 the seven cities largely of American stock, represented in the top bar of the graph, lacked, therefore, about 38 percent of having enough children to maintain their population permanently without accessions from outside, and all cities of over 100,000 population had a deficit of nearly 20 percent, while the smaller cities had a deficit of about 6 percent. On the other hand, the rural nonfarm (mostly village and suburban) population had a surplus of 30 percent, and the farm population a surplus of 50 percent. In 1932 urban deficit and rural surplus about balanced.

people who are rural. If births should continue to decline at the rate of 100,000 a year, as they have during the past 4 years, the maximum population, roughly 129,000,000, would be reached about 1941.

Other Factors Affecting the Population Prospect

Three other factors, however, need to be considered in estimating the future population, the net effect of which suggests a larger figure than those given above. These are (1) the increase during the next decade or two in the number of women of childbearing age, the heritage of the higher birthrate and heavier immigration of the past; (2) the probable increase in marriages (postponed during the depression) with the return of prosperity; and (3) the increase in number of deaths which must soon set in, not because people will die younger, but because there is a rapidly increasing number of old people.

POPULATION OF THE UNITED STATES, 1850-1930 AND ESTIMATES OF POPULATION, 1930-1960

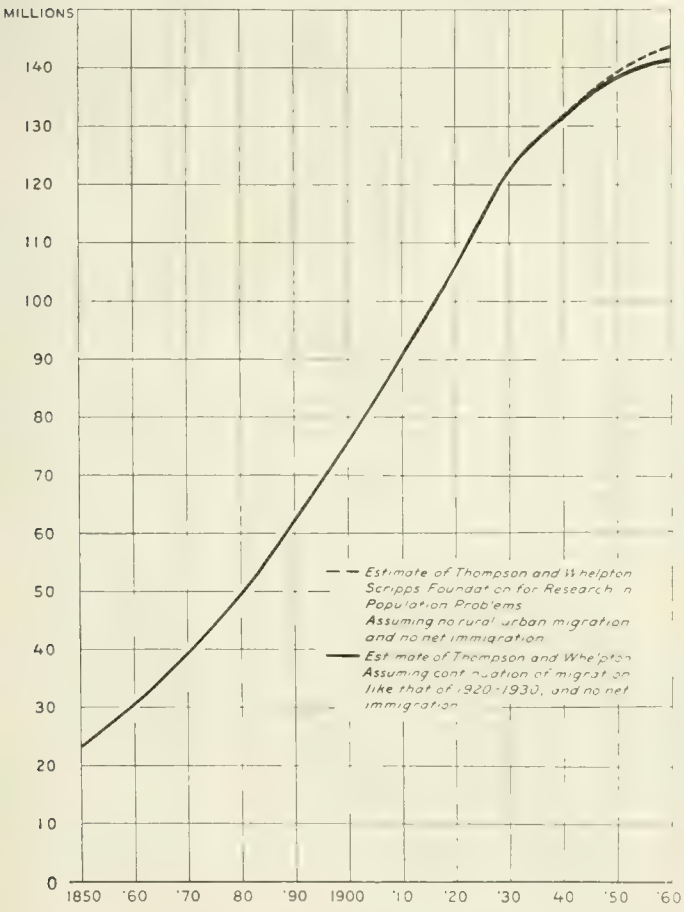


FIGURE 4. Prior to the Civil War the population increased in geometric ratio, doubling every quarter century. From the Civil War to the World War it increased at an arithmetic rate, ranging from 12,000,000 to 17,000,000 each decade. This rapid increase continued up to 1923, owing in part to immigration, except during the World War. Since 1923 the increase of population has diminished. During 1920–23 the annual increase averaged considerably over 1,800,000 a year. In 1932 and 1933 it was less than 800,000. This is owing mostly to the decline in births. If this decline should continue, but at a rapidly lessening rate, so that the specific birth rate were 30 percent less in 1960 than in 1930, the population of the United States would slightly exceed 140,000,000 in 1960. If migration from the farms to the cities is resumed on a scale similar to that between 1920 and 1930, and assuming no net immigration from abroad, the population of the Nation is estimated at about 141,500,000 in 1960, but if no internal migration occurs it will be about 143,900,000. Should the birthrate decline more rapidly or less rapidly than assumed, the estimate would, of course, require alteration. It may be noted that about half of the 30 percent estimated decline in the birthrate between 1930 and 1960 has occurred in the last 4 years. But marriages deferred during the depression may induce a temporary rise in the birthrate during the next few years.

The Population Outlook

In making a forecast of population growth all the above-mentioned factors must be taken into account and assumptions made as to their effects on future growth. Two estimates are presented in table 1. The first assumes that there will be no net movement of people from country to city or between States; the second that the net movement will be similar to that between 1920 and 1930. In other respects the two estimates are based on the same assumptions—(1) that by 1960 the birthrate will fall to about 70 percent of the 1930 level; (2) that the average length of life will increase by about 5 years during the same period; and (3) that there will be no net foreign immigration. On these assumptions population will still be growing slowly in 1960, but the total increase between 1930 and 1960 will be little in excess of the increase between 1920 and 1930. Soon after 1960 the population will have reached its greatest size and will begin to decline. If the assumptions regarding the decline in the birthrate and the increase in average length of life should prove too optimistic, then, of course, these estimates will prove too large.

Age Composition: Although the population may remain within 15 percent of the present number for 25 years, possibly 50 years to come, it will consist of fewer young people and of more and more old people. (See fig. 5.) Between 1920 and 1930 the number of people over 65 increased 34 percent (50 percent in the urban

PROPORTION OF THE POPULATION IN VARIOUS AGE GROUPS, 1850-1930, AND THOMPSON'S AND WHELPTON'S "LOW" ESTIMATE, 1930-1980*

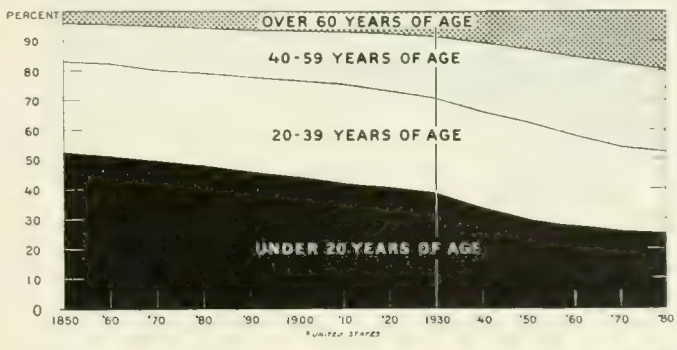


FIGURE 5.—In 1870 over half the population was under 20 years of age, but in 1930 less than 40 percent. By 1950 these children and young people probably will constitute only 30 percent of the population and by 1980, or before, only 25 percent. In 1870 about 5 percent of the population was over 60 years of age. By 1930 the proportion had risen to 8.6 percent. By 1950 these old people will constitute 13 percent of the population, and by 1980 probably 20 percent. In 1870 about 45 percent of the population was between 20 and 60 years of age, which may be considered the productive years of life, taking the people as a whole. By 1930 people in these productive ages constituted 52.6 percent of the total population. By 1950 they will constitute about 57 percent, and by 1980 perhaps 55 percent. During the next few decades, when population will be almost stationary, a larger proportion of the population will be of productive age than in the past, or, probably, in the more distant future.

population), and a similar increase will continue for several decades. (See table I.) At present the percentage decrease of children under 5 is almost as rapid as the increase of people over 65 years of age. This aging of the population presents many economic and social problems, some of which are touched on in later portions of this report. The proportion of the population in the productive years of life, 15 to 65, or 20 to 60, will increase for at least two decades.

Rural and Urban Composition: The proportion of the population that is rural and urban may also change notably. (See fig. 6.) If no net migration, either from country to city or from State to State, occurs, the urban population would increase a little between 1930 and 1945, and then decline slowly; the rural nonfarm population would increase 10 percent between 1930 and 1940, but only 6 percent between 1950 and 1960; while, due to differences in birthrates for the three classes of population, the rural farm population would increase 17, 15, and 12 percent, respectively, during the three decades. (See table I.) If internal migration is resumed in magnitude like that from 1920 to 1930, the urban population would increase 10 percent between 1930 and 1940, about 6 percent between 1940 and 1950, and 2 percent between 1950 and 1960; the rural nonfarm population would increase practically the same as though no migration occurred (it receives about as many migrants as it loses); and the farm population would decrease slowly.

The Outlook for Population Change by States: The estimates of future changes in rural and urban population, based on these assumptions as to migration, births, and deaths, are shown for each State in figure 7. That some net migration from rural to urban areas will occur in the future seems probable, but that it will be as large during the next 10 years as it was during the years 1920–29 seems improbable. Actual developments, therefore, seem likely to lie between the extremes shown by these maps.

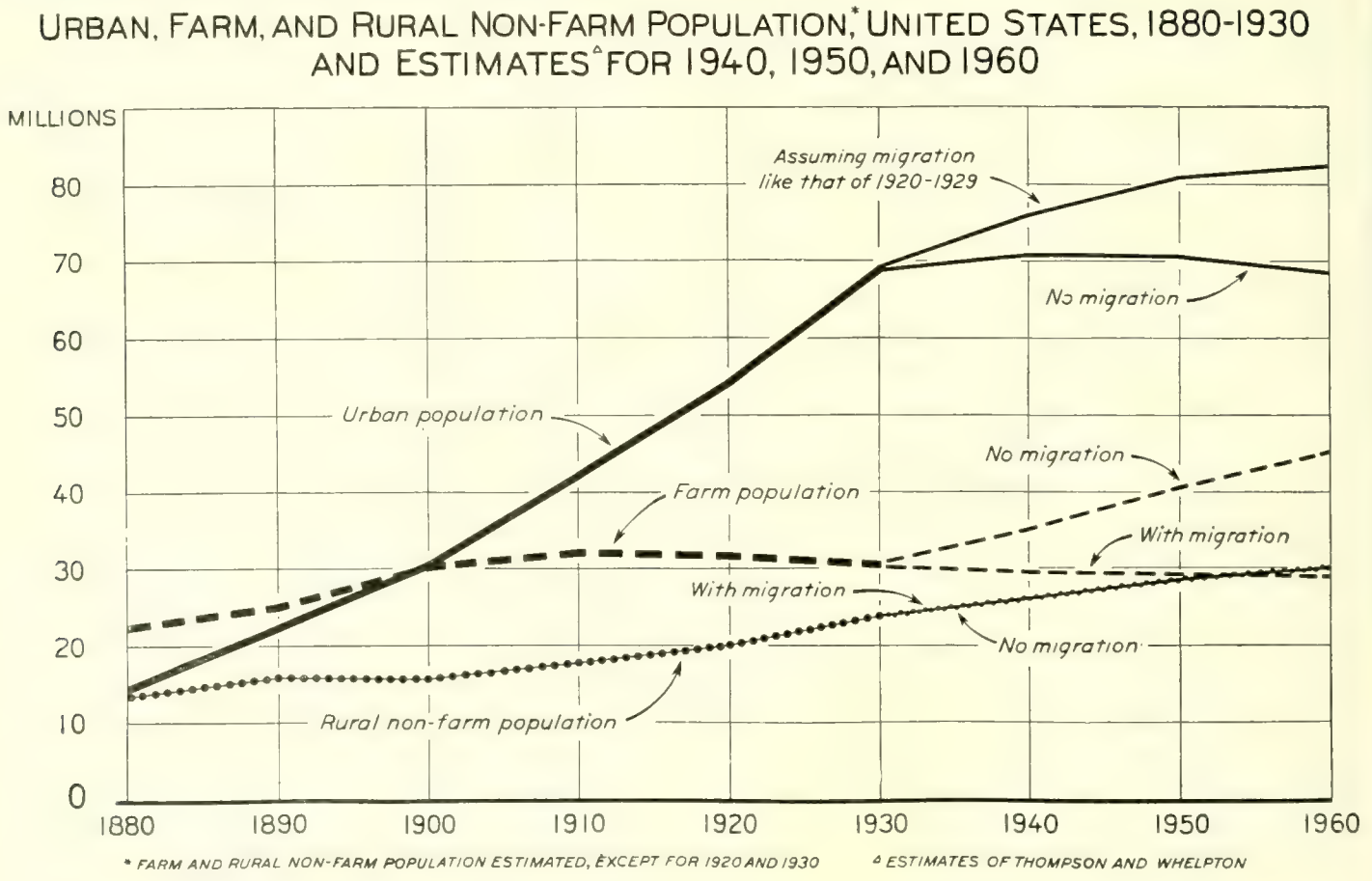


FIGURE 6.—During the half century, 1880–1930, urban population in the United States increased more than fourfold, rural nonfarm population (estimated prior to 1920) nearly doubled, and rural farm population increased scarcely a half. Practically all of this increase in farm population took place before 1910, little change in number occurring between 1910 and 1930. Looking to the future, and using Dr. Thompson's assumptions as to births and deaths, with no net immigration from foreign lands, it appears that the urban population, under the assumption of no internal migration, will increase less than 3 percent by 1945 and then decline slowly; rural nonfarm population will increase gradually until after 1960, by which year it will be about one-fourth larger than in 1930, while rural farm population will increase by about a half. But assuming the continuation of the 1920-29 migration, urban population will continue to increase until after 1960, by which year it will be nearly 20 percent larger than in 1930, rural nonfarm population will increase about the same as if no migration occurred, while farm population will slowly but constantly decline.

TABLE 1.—*Population estimates, United States, 1940–60 (Thompson and Whelpton)*

[Numbers are in thousands]

Year	Assuming no internal migration				Assuming continuation of migration, 1920–29			
	Total	Urban	Rural nonfarm	Rural farm	Total	Urban	Rural nonfarm	Rural farm
1930								
0 to 4	11,912	5,857	2,579	3,476	11,912	5,857	2,579	3,476
5 to 14	24,639	12,174	4,938	7,527	24,639	12,174	4,938	7,527
15 to 39	50,622	30,185	9,303	11,135	50,622	30,185	9,303	11,135
40 to 64	29,423	17,438	5,383	6,601	29,423	17,438	5,383	6,601
65 and over	6,637	3,526	1,559	1,553	6,637	3,526	1,559	1,553
Total	123,233	69,180	23,762	30,291	123,233	69,180	23,762	30,291
1940								
0 to 4	10,857	4,682	2,308	3,916	10,668	5,330	2,352	2,986
5 to 14	22,245	10,762	4,797	6,886	22,240	11,529	4,877	5,834
15 to 39	55,179	29,731	10,633	14,816	55,178	32,472	10,614	12,092
40 to 64	35,434	21,475	6,535	7,423	35,408	22,112	6,466	6,830
65 and over	8,385	4,384	1,841	2,160	8,372	4,596	1,880	1,896
Total	132,098	70,785	26,113	35,200	131,865	76,039	26,188	29,638

TABLE 1.—*Population estimates, United States, 1940–60 (Thompson and Whelpton)*—Continued

Year	Assuming no internal migration				Assuming continuation of migration, 1920–29			
	Total	Urban	Rural nonfarm	Rural farm	Total	Urban	Rural nonfarm	Rural farm
1950								
0 to 4	10,823	4,201	2,410	4,212	10,387	5,155	2,434	2,799
5 to 14	21,372	8,815	4,605	7,952	20,854	10,765	4,708	5,380
15 to 39	56,130	27,460	11,461	17,210	56,100	32,604	11,475	12,021
40 to 64	40,245	24,379	7,598	8,268	40,198	26,120	7,498	6,580
65 and over	10,973	5,804	2,287	2,882	10,904	6,217	2,342	2,345
Total	139,542	70,658	28,360	40,525	138,442	80,862	28,456	29,124
1960								
0 to 4	10,011	3,613	2,274	4,124	9,366	4,682	2,304	2,380
5 to 14	20,844	7,931	4,686	8,227	19,871	10,142	4,755	4,974
15 to 39	54,200	24,492	11,651	18,057	53,632	30,858	11,710	11,064
40 to 64	44,954	24,851	8,640	11,464	44,853	28,532	8,588	7,733
65 and over	13,878	7,662	2,848	3,369	13,763	8,222	2,841	2,700
Total	143,887	68,549	30,098	45,240	141,485	82,436	30,197	28,851

[1] This is larger than the census figure, because of an allowance for underenumeration of young children.

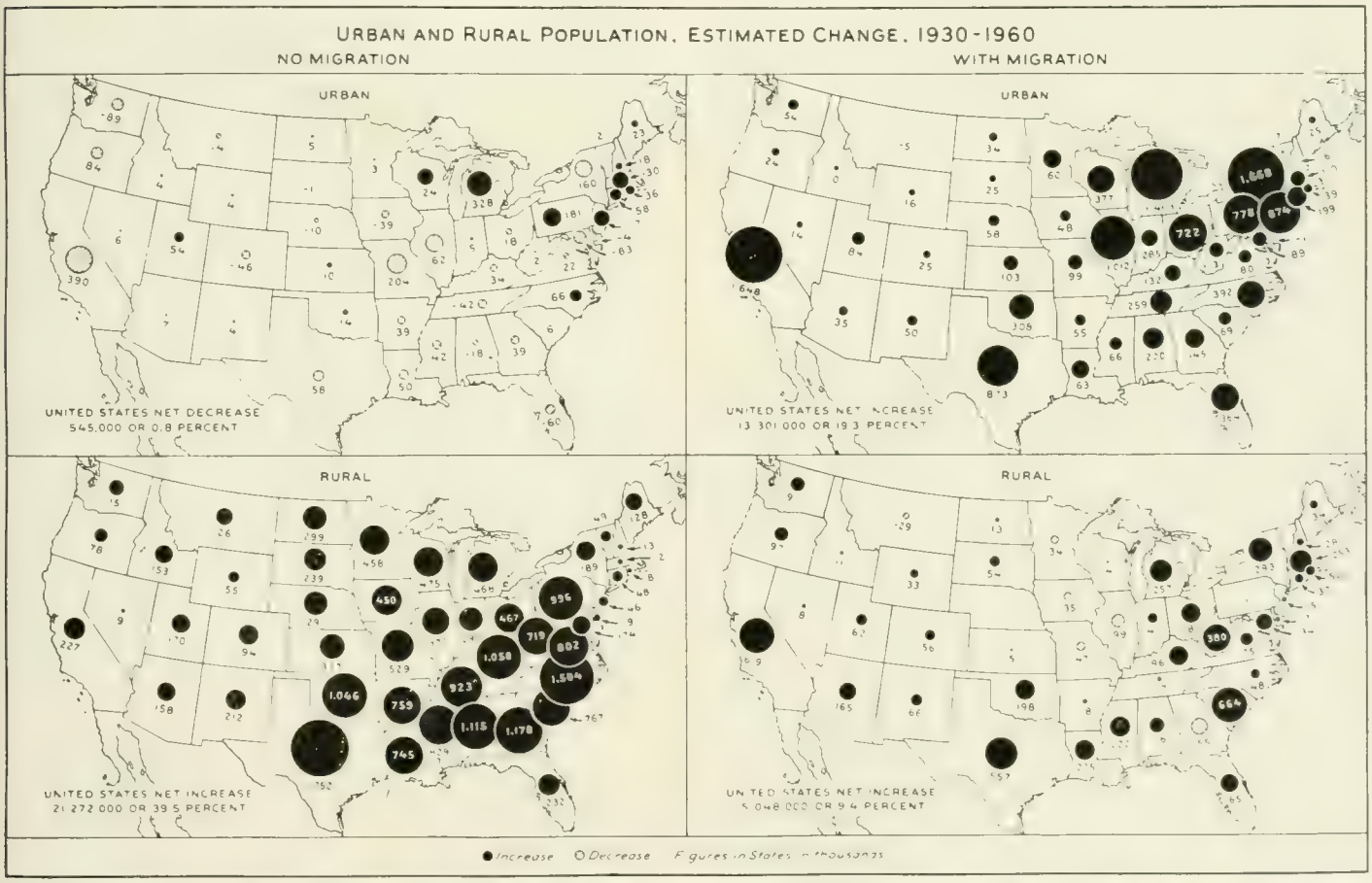


FIGURE 7.—If migration from the rural to the urban areas is not resumed, the urban population seems likely to be smaller in 1960 in most of the States, except the New England States, New Jersey, Pennsylvania, Michigan, and Minnesota, while the rural population will increase in every State. The increase in population will be large in the South, in several States exceeding 1,000,000. Such an increase in population wholly rural (except in North Carolina) should induce an extensive regional increase in agricultural land. But if migration from the farms and villages to the cities is resumed in predepression magnitude, the urban population will increase in nearly every State, while the rural population will decrease in a number of the States, notably those from Illinois to Minnesota and Kansas. The large increase in population will take place in the manufacturing belt north of the Potomac and Ohio Rivers and in California. This increase in population in the dominantly urban States is likely to be associated with a large increase in part-time farms, the homes of people who work in the stores, offices, and factories of the cities and villages.

SECTION I

II. THE OUTLOOK FOR INDUSTRIAL CONDITIONS AND EMPLOYMENT*

General Bearing on Land Utilization

As already noted, unemployment in industry stimulates a migration from cities to farms, and—even more important—it suspends the flow of surplus farm population to other forms of employment. These results aggravate the agricultural situation by reducing real farm wages, increasing somewhat the aggregate farm output, lessening to some extent urban requirements for farm products, and notably weakening the effective demand for farm products, besides numerous other economic and social consequences, including the influence on population increase already described. The resumption, nonresumption, or only partial resumption of full employment will obviously affect materially the extent and character of land requirements and will determine in a measure the policies to be followed with reference to land tenure and settlement. Long-continued unemployment will tend to increase the amount of available labor per acre, with a consequently lessened tendency to employ farm machinery and to increase the size of farms. This might result in increased output per acre, but reduced output per man.

Industrial Outlook for the Immediate Future

The 1932–34 recovery was a result largely of replacement buying by consumers and speculative accumulation of inventories by processors and distributors. It was seriously retarded in the United States by the still unliquidated remains of the banking collapse of early 1933. It may have been stimulated somewhat, for a time at least, by our monetary policy, and by the codification of industry in the summer and fall of 1933. Abroad, it was influenced by other factors, such as currency depreciation (notably in Japan), and revision of tariff policies (as in Great Britain), and development of new resources and reconstitution of debt structures, as in Canada and Australia. In this country the initial urge of these forces is now largely spent, so far as current business activity is concerned, and adverse influences, such as price maladjustments, rising costs of production not offset in all cases by price advances, and labor difficulties, have arisen. Consequently, the recent upward trend of industry was temporarily reversed during the summer of 1934.

The last 2 months of the year are likely to show some improvement owing to increased governmental expenditures, temporary recovery of activity in cotton and steel mills after the July to September slump, and continued large volume of retail trade which is showing its customary lag behind movements in heavy industry. Continued heavy expenditures of Public Works Administration funds on construction indicate it is probable that the normal seasonal expansion will be realized next spring, resulting in a level of activity next year substantially higher than during the last half of 1934.

Looking Several Years Ahead

The fundamental economic situation is dominated by a number of important factors. A thorough appraisal of the possibilities for wide-spread revival of industry is beyond the scope of this report, but it is essential that some notice be taken of the prospects for industrial activity if no new major stimulus and no definite governmental action is taken to create jobs for the 10 million still unemployed. A few of the major branches of industry are subsequently considered in the light of both the present demand outlook and possible changes in demand.

A major economic consideration is building space and plant capacity. Under present demand the latter is excessive, but the excess is gradually being reduced by obsolescence.

The improvement in public buying power since the spring of 1933 has accelerated the tendency. At present a marked shortage in small houses exists, but there is still a heavy surplus in commercial and industrial structures. The growth in population is now less

SUPPLY OF FARM LABOR AND INDUSTRIAL EMPLOYMENT, INDEX NUMBERS, FOR MARCH, 1919 TO DATE

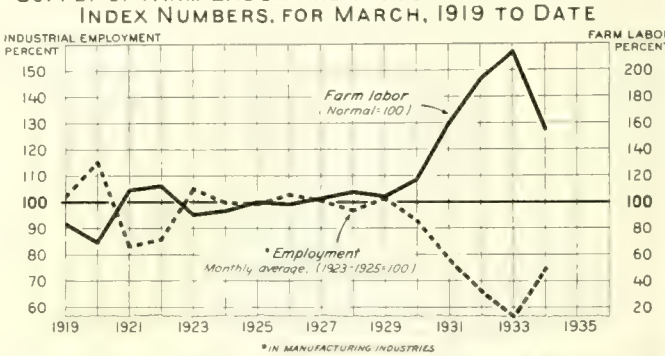


FIGURE 8.—The supply of farm labor in relation to the demand varies inversely with industrial employment. Full industrial employment absorbs the surplus farm population in urban industry. Industrial stagnation and urban unemployment back up the rapidly increasing farm population in the country, increase the stream of migration from urban to rural areas, and produce an oversupply of farm labor. If not reabsorbed in industry this oversupply leads to increased farm production and to reduced city demand for commercially produced farm products.

* The following persons have contributed material which has been utilized in preparation of this chapter: Mordecai Ezekiel, economic advisor to the Secretary of Agriculture; and L. H. Bean and L. M. Graves, Agricultural-Industrial Relationships Section, Agricultural Adjustment Administration.

than half of what it was before 1926, and the low average level of per capita income operates to retard the revival of home building. Generally speaking, we are still in the trough of the major construction cycle. Without strong support by the Government several years would probably be required for complete readjustment making possible a broad, sustained expansion in building. The Government housing program of the dimensions already provided for should exert some stimulus, but it is generally agreed that if building activity is to increase sufficiently to carry other industries to permanently higher levels of activity, a large building program supported by the Government is necessary.

The long-time prospects in the motor-car industry depend largely upon the course of the national income. At the present time total registrations are probably about three million vehicles below the 1930 total, and production in 1934 may be about sufficient for present annual replacement needs, taking the expanded life of cars into account. In 1929 a substantial portion of the industry was dependent upon foreign outlets which have since sharply dwindled. During this depression consumers naturally have curtailed their expenditures for automobiles somewhat more than for other items in their budget. General recovery during the next few years should therefore release a somewhat larger proportion of the national income for the automobile industry. Judging from past experience, it would appear that if the national income could be raised from its present annual level of about 50 billion dollars to about 70 billion, about 5 million automobiles could be sold annually if wholesale prices are kept down to about $500 per car. While this would be about twice the 1934 volume of production, it would still be considerably less than the 1929 level. The extent to which this avenue of employment can be expected to reabsorb its former number of industrial workers depends upon a restoration of general activity and a restoration of export demand. Offsetting these prospects are, of course, recent and prospective technological developments tending toward greater output per worker.

Railway traffic, owing to competition of other forms of transportation and changes in industrial production and technique, has been declining relative to physical volume of production for a number of years with a much sharper reduction after 1930. Part of this loss may therefore be expected to be recouped during the next few years, but if so, it might be at the expense of employment in competing transportation. While the outlook for railroad purchases depends very much on the arrangements to be worked out by the governmental agencies and railway management, without a marked change in fundamental policy the program of maintenance and equipment purchases by railroads during the next 3 to 5 years will have to be held at a minimum unless traffic volumes prove larger than now seems probable. We must reckon with the possibility, therefore, that this industry will afford little support to general industrial activity, particularly steel and railway equipment, and will be an adverse influence in the financial situation.

The real contribution of the railroads to business revival depends upon the program of maintenance and equipment purchases during the next few years. The present tendency in view of current low earnings is to hold these capital expenditures down to a minimum and to seek improved earnings through raising still further out of line the general level of freight rates. There are, however, possibilities for potent contribution to industrial revival in a broad program of reequipment along modern lines. This new investment would be amply justified by the reduced costs of operation. To be really effective in restoring and maintaining general industrial activity, such a program would need to be of substantial proportions and would probably need Government support of some sort. The promotion of reemployment through this means apparently awaits the enunciation of the general outlines of the future national policy with respect to the railroads and other forms of transportation.

Activity in the steel industry, which was raised to artificial levels by the abnormal increase in the quoted prices for steel last spring, is currently suffering from lack of orders, while consumers are using up their accumulated stocks. Later in the year, when consumers are forced back into the market and new automobile models are being produced, there will be some revival in steel activity. During 1935, however, particularly the first half, steel operations will be likely to compare unfavorably with 1934. The three great consumers of steel are ordinarily the motor industry, building, and the railways. As indicated above, barring the influence of fundamental changes due to governmental policy, the outlook in these is for a restricted rate of activity on the average for the next several years. Miscellaneous requirements, which account for about half of the normal steel consumption, are likely to do somewhat better.

Some Factors Influencing the Industrial Outlook for the More Remote Future

Some of the changes in number and composition of the population, outlined above, have important, though somewhat mixed industrial implications. The declining rate of increase may exert some depressing influence on the tendency to provide excess plant capacity predicated on future increase. It will also tend to lessen the requirements for new dwellings to provide for a large increase in number of families. If the population of the Nation becomes less migratory this will also lessen the requirements for new houses in areas that

would otherwise have an accession of migrants. The larger proportion of the population in employable age groups during the next two decades, noted above, will make for increased output and higher living standards if we can find means for full employment. Otherwise, it will likely intensify the unemployment problems.

International trade and international relations generally must be considered in attempting to estimate the industrial outlook, whether for a short or a long view. While trade in general has been restricted by the depression, international trade has suffered in addition from the drastic restrictive measures undertaken by practically all governments. Although international trade would perhaps in any case have tended to decrease in relation to world production, artificial barriers to trade must be regarded as the main cause of the relative decline of international trade in recent years. The newer restrictions are the result both of deliberate economic nationalism and of the dislocation of international finance which has been caused mainly by the virtual cessation of international capital movements. Governments have sought to remedy disturbances in the balances of international payments of their countries and to reduce unemployment by the short-sighted method of emergency tariff duties and other import restrictions. But the continuance of such restrictive policies is so patently suicidal that even the most nationalistic governments are now alarmed by the decline of international trade. Present policies are, therefore, being greatly influenced by the aim of removing or circumventing some of the existing obstacles to trade through reciprocal tariff agreements and barter arrangements. It is too early to forecast the results of these efforts. It must be recognized, however, that steps to be taken by our own Government may exercise a material influence, and that a distinct revival of international trade over a long period, resulting from reductions of trade barriers and stabilization of international financial relations, is a very real possibility.

Possible Measures for Increasing Aggregate Employment

The development of new products, such as aircraft, air-conditioning equipment, fabricated houses, and other innovations, will in time afford a considerable amount of new employment. Government aid in research and financing of such developments may be useful in some cases. In most instances, however, they are likely to be brought about by large companies having adequate laboratories and financial resources.

Decentralization of industry is often mentioned as a means to increase employment, especially in the integration of agricultural and industrial occupations. Such a tendency may promise not only a considerable expansion of employment in effecting the requisit changes in the location of industrial plants and th relocation of housing facilities, but it is believed t afford a promise of increased economic stability. It i difficult at this time to determine whether decentrali zation has or has not more than offset recently th opposite tendency to concentration. Statistics indicat that both tendencies have been operative in our eco nomic life. The increase of decentralization through private initiative not stimulated by governmenta policy is likely to be influenced by a number of impor tant conditions, including long-distance power trans mission, development of highways, motor-truck lines and water transport, the optimum size of the pro ductive unit in various industries, importance for par ticular industries of accessibility to local markets and concentrated supplies of skilled labor, and other eco nomic requirements peculiar to particular industries, as well as various noneconomic considerations. The Nation, as well as industrial interests, is vitally concerned with having these possibilities adequately explored, including the ways in which governmental policy may advance or retard decentralization. More light on this subject than is now available will be of outstanding significance in the shaping of the national land policy and program.

Self-help and barter organizations are another means proposed for creation of employment. This is a type of emergency relief which serves to maintain the self-respect of the unemployed and does add somewhat to total employment and production. It also presents serious problems of distribution which may prevent its rapid development on a scale contributing materially to industrial expansion. It may be regarded in general as an inefficient makeshift pending the restoration of normal activity, either by spontaneous private initiative or through such special stimuli as may be provided by governmental action. In general, wholesale reduction of unemployment cannot be achieved in the next year or two—probably not in 5 years—by promotion of new products or new principles of industrial organization.

Since these prospects for increasing employment by new industries and decentralization do not promise early stimulation of employment, restoration of activity in established industries appears essential. The problem is to resume operations in the shortest possible time compatible with any fundamental readjustments which may be desirable.

As this cursory description has indicated, there are many stubborn problems to be solved before this broad objective is achieved. The degree of governmental assistance or participation necessary to that achievement is being gradually determined by the combined

efforts of the private and governmental agencies. But restoration of industrial activity is important for the most satisfactory land program.

Since the inception of the industrial depression some 3 millions of persons have either migrated to the country or have been prevented from moving to the cities as they otherwise would have done. For a program of planned land use the problem is further aggravated by the migration of a large proportion of people to the poor land areas. The continued existence of unemployment on the present scale will materially affect the character of our land policies. However much we may hope for better things, the balance of probability seems to point to a considerable amount of unemployment for a number of years, though it may be, indeed must be, greatly reduced below the present level. At best it appears doubtful that the surplus population from the farms of the Nation will be as fully absorbed in other industries, during the next 5 or 10 years at least, as has been the case in the past. This probability, as well as the prospect for an increasing proportion of the aged, must be held in view in considering the land requirements and land policies of the Nation.

The above statement summarizes the probable trend of industrial development during the next few years, so far as can be judged from developments to date. It assumes that, by and large, great numbers of people who, if they followed the usual process of industrial evolution, would shift from farming to industry, will instead remain in rural districts on a near subsistence level, and also that large numbers of workers displaced from industry during the period of the depression will not be effectively reabsorbed.

There is, however, an alternative possibility that methods will be worked out, perhaps by devices not yet developed, or by governmental or other policies not yet tested out, that will result in full and effective utilization of the available resources and man power in this country to satisfy the consuming desires of the great mass of the workers far nearer to an adequate level than the progress estimated above would make possible.

PRODUCTION OF MANUFACTURES, FACTORY EMPLOYMENT, AND POPULATION, UNITED STATES, 1899 TO DATE

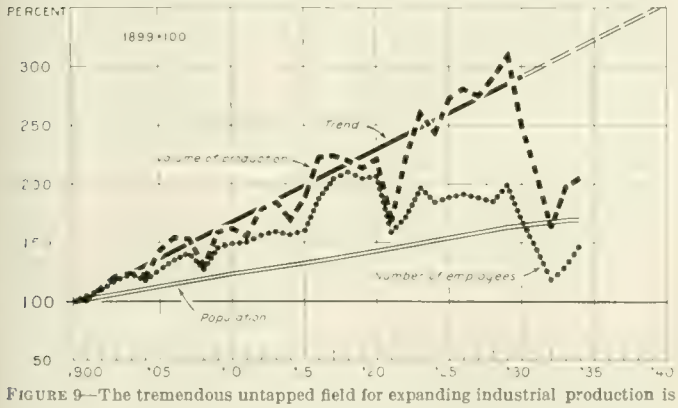


FIGURE 9—The tremendous untapped field for expanding industrial production is indicated by the relative positions of the curves for current production of manufactures and the trend of such production during the period 1899–1929, projected to 1940. In the past, production of manufactures has increased faster than population, but it would require a 50 percent increase in current industrial production merely to bring it up to the per capita figure of 10 years ago. This would probably do a great deal to restore a balanced relation between agricultural and industrial prices and between farm and national income

The possibilities of a very great industrial expansion during the next few years are shown by the fact that in September 1934 industrial production was at 71 percent of the 1923–25 average, and construction activity was at 27 percent of that average. Population increased nearly 12 percent during the 10 years from 1924 to 1934. On a per capita basis, industrial production at the present time is, therefore, more than one-third below the level of 10 years ago and construction activity three-fourths below that level. It would, therefore, be necessary to increase the rate of industrial production by 50 percent and the rate of production in construction by 300 percent to bring them up to the per capita production of 10 years ago. In addition, there has always been in the past a more rapid growth in industrial production than in population, owing to the increasing efficiency of labor with the new improvements in techniques. This progress is what has made possible rising standards of living. The records from industrial plants show this increase in technological efficiency has been maintained and perhaps even been accelerated during the depression. Without going into the specific measures of this rate of increase in technology, it would appear easily possible for this country to absorb and use effectively an urban production, including both manufacturing industry and construction, of twice the present magnitude if only effective methods could be found for coordinating production, purchasing power, and consumption. (See fig. 9.)

While it is by no means clear how such fuller utilization of resources to reestablish even the previous rate of industrial production per capita can be brought about, it is apparent there is a tremendous untapped field for expanding industrial production and other forms of urban economic activity at the present time.

As will be pointed out later, a greater industrial activity would carry with it a materially expanded city demand, and a material increase in consumption of the more highly specialized farm products, including meats, dairy products, fruits, and vegetables. To the extent that such full utilization of our industrial resources and technological progress can be brought about, there will be demand and purchasing power in the cities to justify the use of a much larger area of land in agricultural production than would otherwise be the case. If such a rapid expansion of industrial production and consumption could be brought about, the problem of land use would very soon center more largely on seeking more efficient use of available areas and on bringing in new areas to provide for this rising standard of living and for the gradual increase in population.

SECTION I

III. RELATION OF MECHANICAL PROGRESS IN AGRICULTURE TO LAND UTILIZATION AND LAND POLICY*

Economies in Human Labor

The breakdown of the industrial system in the past few years, which has checked the flow of farm population to cities and contributed to a marked increase in the available supply of farm labor, runs definitely counter to the tendency to substitute mechanical power for human labor in both agriculture and industry. Farm machines released from agriculture a large proportion of the man power needed for the industrialization of the Nation. Industrialization, in turn, greatly increased the Nation's requirements for agricultural products and its ability to purchase them. The Civil War stimulated a great increase in the use of all types of farm machinery, enabling a smaller number of agricultural workers to produce the necessary food supply. With the increase of western migration about 1875, steel plows of great strength, especially shaped and carefully finished for easy scouring, were manufactured for breaking up the prairies, buffalo sod, underbrush, and rough virgin sod west of the Great Lakes region. In the early eighties gang plows, equipped with stubble or sod plow bottoms, for use with steam engines, were manufactured, enabling farmers to plow a larger acreage than with horse-drawn equipment. Between 1900 and 1910 internal combustion engines were introduced for use on farms. The World War period created a serious shortage of farm labor in conjunction with an acute scarcity of agricultural products. Development of the farm tractor reduced labor requirements in agriculture while making it possible to put new land under cultivation. From 1915 to 1920 light weight, high-speed gas tractors appeared. Farm machinery manufacturers made greater use of alloy steels, drop forgings, cut gears, antifriction bearings, dust-tight construction, working parts running in oil, and accurate machining to fine limits. About 1925 revolutionary changes took place in farm tractor design. Successful all-purpose tractors were introduced, which were suitable for every type of row-crop work from plowing to harvesting. In addition they furnished efficient belt power for feed grinding, ensilage cutting, wood sawing, and other chores, and through the power take-off mechanism operated trailed machines, such as sprayers, dusters, small combines, corn pickers, and potato diggers.

As a result of these and other improvements it is estimated that the efficiency of human labor in agriculture has increased approximately 30 percent on the average for the entire United States since 1909.

Facilitating the Use of New Areas or the More Intensive Use of Old Areas

Agricultural mechanization has made possible the utilization of areas that could not otherwise have been employed for cultivation, and profoundly modified the relative value of different types of land for agricultural uses.

The advent of the steel plow and the reaper in the middle of the last century facilitated the utilization of land in the prairie States, hitherto but slightly developed, converting that vast wilderness into the granary of the United States.

The Great Plains were made available for cultivation largely as a result of farm machinery. The later development of this territory came about through the introduction and improvement of the tractor, header, combine-harvester, lister, one-way plow, drill, and improved well drilling equipment. Corn and grain sorghums have been successfully grown under semi-arid conditions, principally through the use of listers and semi-listers. Deep-furrow grain drills have been indispensable in planting wheat. Mesquite and brush lands have been made available through the use of brush breaker plows. Duck-foot cultivators and rod weeders have facilitated extensive and efficient summer fallowing. By application of machinery and engineering practices wet lands have been drained, dry lands have been irrigated, stumps, brush, and stones have been removed from cut-over lands, thereby converting formerly worthless land into some of our best farming areas. Wheel and crawler type tractors with proper attachments and implements have made possible the production of crops on lands that never could have been cultivated efficiently with animal power. The heavy black gumbo soils of many States require special plows; rice harvesting, special binders; California citrus country, special disc harrows and deep tillage tools; and soy bean harvesting, especially equipped combines. Transplanting machinery has greatly extended truck crop acreage. Pest control equipment has made it possible to farm more profitably

*R. U. Blasingame and W. M. Hurst, of the Bureau of Agricultural Engineering, contributed material which has been utilized in the preparation of this chapter.

in areas where certain types of insect pests and diseases have been prevalent; the corn borer, potato blight, and insects in orchards and vegetable crops are examples.

For a time the process of mechanization placed a special premium on areas of smooth terrain and emphasized the handicaps of areas of more uneven topography. The change in emphasis is likely to continue; nevertheless, recent developments have tended to adapt labor-saving mechanisms to the areas of less favorable topography, as, for instance, the crawler tractor, self-leveling combine-harvesters, and various other machines.

The Influence of Good Roads, Motor Vehicles, and Rural Electrification

The relative significance of different locations for agricultural land use is being definitely influenced by the penetration into the country of urban standards of living. The residents of the more remote and less favored areas have become increasingly less willing to continue the crude pioneer modes of living which formerly proved satisfactory. The spread of rural electrification has made possible such improvements in modes of living as electric light, running water, electric cooking, refrigeration, and radio. The significance of this development is emphasized by the fact that the construction of 350,000 miles of rural electric power lines during the last decade has advanced the use of electricity from 177,000 farm customers at the beginning of the decade to 710,000 at the end of it. In addition to the increased use of high-line electricity on farms, it is estimated that 250,000 individual electric-light plants are in operation.

It seems probable that the cost of electricity and farm power will be substantially lowered in the near future. High-line electric current will be made available for a much larger proportion of the farm population, and fuller use will be made of available facilities. Mechanical-power costs probably will be lowered by the further perfection of both the carburetor and the Diesel types of engines through improvements in design and in quality of materials. These developments will stimulate increased use of power on farms, which, in turn, will increase the amount of work that can be accomplished per man.

Influence on Population Density and Size of Farms

It does not follow, however, that the progressive economy of labor will mean less population on the land. The character of our agriculture is rapidly changing. The movement of population to good roads and electrical power lines is associated with increased opportunities for other sources of income, such as the operation of filling and service stations, refreshment stands, and the development of small local industries. Such a population movement may result in an even greater tendency toward the processing and direct sale of farm products, either on the farm, at roadside stands, or by truck transportation to larger markets. There is also a distinct tendency toward quality production, which is being stimulated partly by access to a more discriminating demand, and also by such mechanical developments as sprayers and dusters, fruit washers and graders, vegetable washers, grain dryers and cleaners, fertilizer spreaders and distributors, cotton and hay dryers, and side-delivery rakes. The food value of crops for livestock has been made more usable by improved hay tools, feed grinders, and ensilage cutters. Higher quality in orchard and vegetable crops has been made possible in various sections by the use of pumping equipment for surface and overhead irrigation. Better quality of dairy products at lower costs is possible by the use of mechanical milkers, cream separators, utensil sterilizers, and refrigeration. Mechanical brooders, incubators, refrigerators, and candlers are some of the outstanding items of equipment developed for improving the quality and decreasing the costs of poultry products. These developments, however, are taking place only in certain regions.

In some of the areas of staple production the tendency, as already noted, has been and may continue in the direction of displacement of labor by machinery and a decrease in the population directly supported by the land. Such a tendency in the Cotton Belt would be greatly accelerated by the development of a practicable mechanical cotton picker, which might present serious problems of economic and social adjustment. After many years of trial and failure, a mechanical cotton picker has been brought out of the laboratory phase and may be regarded as in an advanced stage of engineering experimentation. When it becomes commercially available, its influence on land utilization will depend on many factors, such as size, price efficiency, and prevailing rates for picking cotton by hand. It is reasonable to expect that it will be used first to a greater extent in the western section of the Cotton Belt, where labor conditions, climate, and topography favor the use of such a machine. Its adoption in the southeastern section will probably be less rapid in view of the fact that much of the cotton in that section is grown on small farms by tenant families.

The initial influence of agricultural mechanization was to stimulate an increase in size of farms, and the trend in design of machinery was toward larger types. Many observers believed the direction of our economic evolution would be toward large units of the corporate type. However, mechanical invention is rapidly adapting the various types of mechanical equipment to the

needs of the small farmers. The small combine-harvester and the 1-plow tractor adapted to multiple uses, and with a full complement of row-crop equipment adapted to a wide variety of field crops, have already caused a tremendous increase in the amount of mechanical power used on small-sized farms. This development has scarcely begun. It will place a premium on intelligent and experienced types of farm operators and laborers, and possibly stimulate a tendency toward operation by owners rather than by the lower class of tenants.

Obviously, there may be extensive unforeseeable inventions of labor-saving machinery or other technical discoveries for agriculture that may exert a revolutionary effect on both the use of land and on the proportion of the total population employed in farming. It is important to recognize, however, that mechanization implies a commercial, as distinguished from a predominantly self-sufficient, type of economy. If industrial unemployment continues serious, it may so augment the abundance and cheapness of labor that the tendency to mechanization in both agriculture and industry will be retarded. If the migration to the land as a means of escaping the evils of industrial unemployment and the associated retardation of commercial demand contributes to continued overproduction and economic stagnation in agriculture, it is clear that the inevitable tendency will be toward a more self-sufficient type of farming with less mechanization and more dependence on human labor.

SECTION I
IV. SUMMARY

The prospects for population increase do not indicate that our requirements for the various uses of land will severely tax our land resources to supply them. If we husband our natural resources we shall not experience the severe deprivations associated with the extreme population densities of certain other civilized countries. We have no land to waste and we should provide for the adequate protection and use of every acre. Nevertheless, we have sufficient land to provide an ample food supply for the maximum probable population (assuming no extensive resumption of immigration) and to make a relatively abundant provision, as compared with most civilized countries, for forests, wildlife, recreation, and other uses.

The most uncertain element in the outlook, and one that may profoundly influence agricultural land policy particularly, is the prospect for industrial recovery. If we should so order our national economy that all of our human resources could be fully employed in providing for the extensive wants still unsatisfied, we should be free to shape our agricultural policy in the direction of affecting a maximum economy of human labor in order to spare as much labor as possible for nonagricultural employment. This would mean the adoption of all available mechanical and scientific methods in farming and the development of the most efficient types of farm organization. This would imply, of course, the elimination from farming of the numerous farm families now engaged in crude, self-sufficing systems of farming. It would probably make possible reducing the proportion of the population engaged in agriculture by perhaps one-third to one-half.

On the other hand, if full industrial recovery is long postponed or if we find it impossible to adjust our economy so as to prevent the continuance of extensive technological unemployment associated with technical progress, it is clear that our course must be in a different direction. A considerable part of the normal increase in farm population will be unable to find employment in industry and must remain on the land. There will be no point in striving for a maximum efficiency of human labor. Farm and rural community organization will naturally become less commercial and capitalistic and more self-sufficient, and it will be practicable to employ in farming types of land that it would not pay to use under the previous assumption. It is probable that this would subject our people to a lower standard of living than is desirable.

The recommendations relative to agricultural land policy in the present report reflect the conviction that it will be the part of wisdom to steer a middle course between these two extremes. This appears desirable in part by reason of the impossibility of determining the outlook for employment. Even if we were assured, however, of opportunities for employing all the population that could be spared from agriculture, it seems probable that a middle course will be safer and perhaps socially more wholesome than an extreme form of commercial agriculture. The latter might imply, for instance, large capitalistic units dependent in part on hired labor and characterized by a high degree of economic instability. On the whole, it appears wiser to strive for the family farm characterized by a reasonable degree of self-sufficiency, interrelated with forest, wildlife, and recreational resources of the countryside, and integrated so far as practicable with other forms of employment for family labor.

PART II—SECTION II

LAND REQUIREMENTS IN RELATION TO LAND RESOURCES FOR THE NATION AS A WHOLE

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SECTION II

I. SUMMARY OF THE PRESENT USES OF THE LAND SURFACE AND OF PROSPECTIVE OR RECOMMENDED USES*

The principal agricultural uses of land are for crops, pasture, and forest, and for farm buildings, yards, and lanes. (See fig. 10.) The principal nonagricultural uses are for cities and villages, for roads and railroads, for cemeteries, and for recreational purposes. Virtually all of the 1,903 million acres of the continental United States have some present or potential use. There are certain arid lands not grazed, bare rock, and some marsh land and coastal beaches which are not now employed, but most of these have possibilities for one form or another of wildlife or recreation. Some land has two or more uses, for example, forest land used for grazing or for game and recreation. The area of land employed for agricultural purposes, including forests, is four-

The following persons have contributed material which has been utilized in the preparation of this chapter: O. E. Baker and E. O. Wooton, Division of Land Economics, Bureau of Agricultural Economics, Francis R. Kenney, Land Policy Section, Agricultural Adjustment Administration.

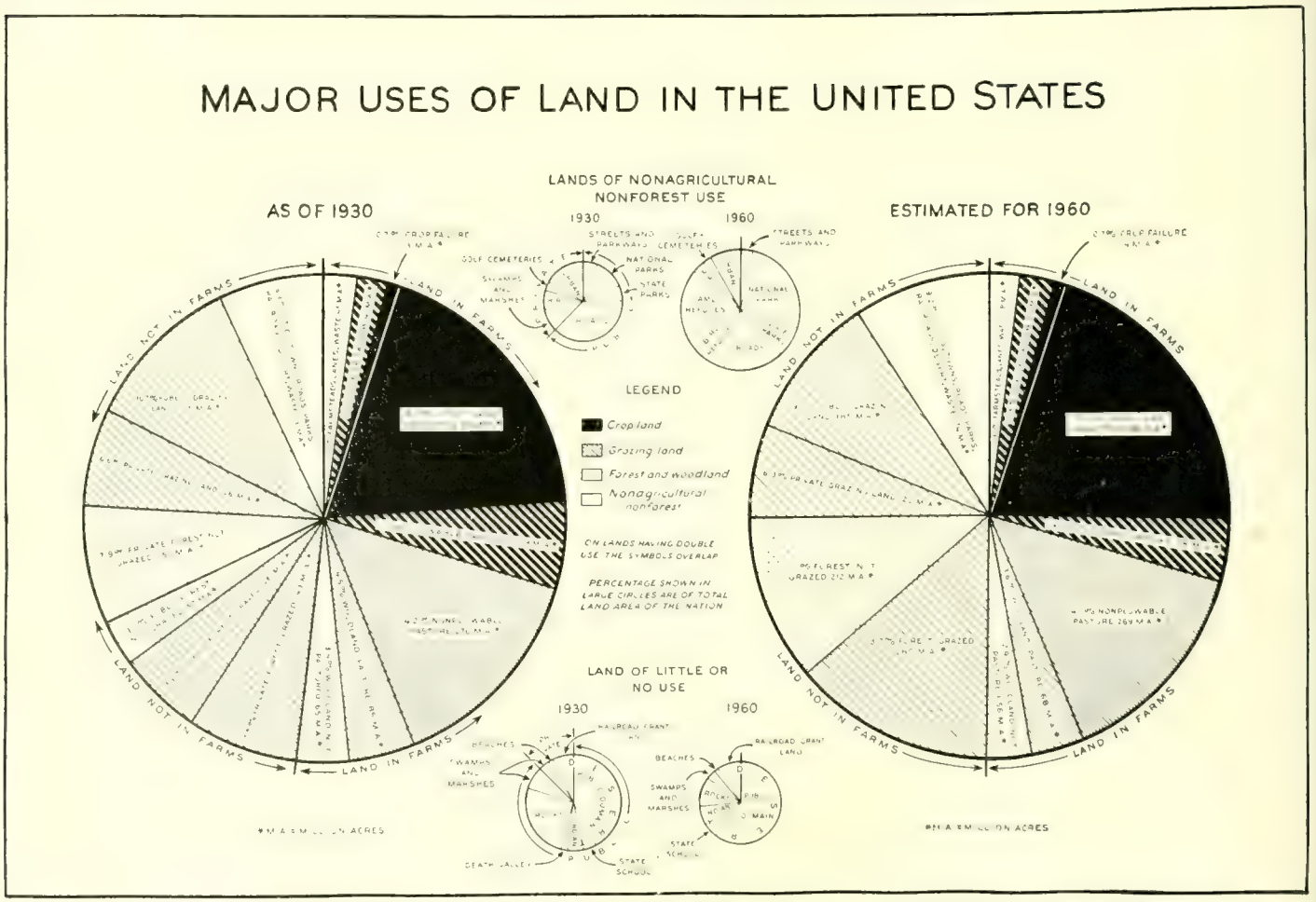

FIGURE 10.—A little over half of the land in the Nation is in farms. Of this land in farms, 38 percent was in crops in 1929 (including crop failure), 37 percent was in pasture (excluding woodland pasture), and 15 percent in woodland, the remainder being crop land lying idle, farmsteads, lanes, and waste land. All crop land is in farms, but the acreage of pasture, including range land outside of farms, exceeds that in farms. About 60 percent of this pasture land not in farms is publicly owned and 40 percent is privately owned. Nearly all this land is in the western half of the country and consists of range, mostly native, short-grass and bunch-grass vegetation adopted to the semi-arid or arid conditions. In addition, much forest and woodland (over one-half) is grazed, particularly in much of the West and portions of the South, where the forest is quite open, permitting sunlight to reach the soil. The carrying capacity of this woodland pasture, like that of range pasture, is generally low. (See table 3.) The 53 million acres of land used for nonagricultural and nonforest purposes is small, but its value is great, particularly the urban land. Finally, there are about 77 million acres of absolute desert, bare rock, certain marsh lands, and coastal beaches which are now valued at almost nothing, but have a social utility for wildlife and recreational use. (Since the graph was prepared further research indicates that the publicly-owned grazing land should be increased to about 235,000,000 acres and the privately-owned grazing land not in farms decreased accordingly. This would change the 60:40 ratio noted above to 70:30.)

Looking to the future, it appears that the estimated prospective increase in population is likely to involve a slight increase in crop land, a decrease of pasture land and of forest in farms, if past trends continue, and increase in forest not in farms, more and more of which seems likely to pass into public ownership, and a notable increase in land devoted to recreational purposes. The increase in crop land will be the net result, as in the past, of decreases in some areas, mostly hilly or eroding lands, or sandy or infertile soils, and increases in other areas inherently more fertile or less exhausted of their fertility, or otherwise more productive, or which can be made productive by reclamation.

teenfold that used for nonagricultural purposes, but the aggregate value of the latter, especially the urban land, is very large. The area of absolute desert and other waste land is larger than that used for nonagricultural purposes, but it has very little value.

Land may be classified also relative to ownership. (See fig. 10.) Practically all agricultural land used for crops is in private ownership in the United States, and about three-fourths of the pasture and of the forest land. Most of the publicly owned grazing and forest land, principally national forests, Indian reservations, and public domain, is in the western States. Urban land is nearly all privately owned, except the streets, roads, and parks. Formerly many of the roads and some of the parks were privately owned, but now ownership is almost exclusively public. The trend in forest land not in farms is now also toward public ownership. Nearly all of the waste land is in public ownership.

The following table provides figures of the area, mostly estimated for land not in farms, of all land in the continental United States classified as to use and ownership. The column of figures on the left shows the areas in 1930, and that on the right the areas of the various classes of land that may be expected by 1960 to be employed for various uses or the areas as suggested in this report. These relationships are graphically presented in figure 10.

TABLE 2.—*Major uses of the land, continental United States, 1930, and estimated or recommended, 1960*

Class of land	1930 Area in millions of acres	1930 Percent of total land area	1960 Area in millions of acres	1960 Percent of total land area
Total land area	1,903	100.0	1,903	100.0
I. AGRICULTURAL AND FOREST LANDS				
All land in farms	987	51.8	952	50.0
Crop land:				
Crop land harvested	359	18.9	386	20.3
Crop failure	13	.7	14	.7
Idle or fallow land [1]	41	2.1	43	2.3
Subtotal	413	21.7	443	23.3
Pasture land:				
Plowable	109	5.7	78	4.1
Not plowable	270	14.2	269	14.1
Subtotal	379	19.9	347	18.2
Woodland:				
Pastured	85	4.5	68	3.6
Not pastured	65	3.4	56	2.9
Subtotal	150	7.9	124	6.5
All other land	45	2.3	38	2.0
Land not in farms	785	41.2	777	40.8
Forest and woodland:				
Grazed:				
Public	106	5.6		
Private	143	7.5		
Subtotal	249	13.1	260	13.7
Not grazed:				
Public	57	3.0		
Private	151	7.9		
Subtotal	208	10.9	212	11.1
Land not in farms—Continued				
Grazing land (not in forest or woodland):				
Public	203	10.7	185	9.7
Private	126	6.6	120	6.3
Subtotal	329	17.3	305	16.0
II. LANDS OF NONAGRICULTURAL NONFOREST USE				
Urban lands:				
Land privately owned	9	0.5	10	0.5
City streets, parks, and parkways (public)	3	.2	4	.2
Golf courses and cemeteries (outside city limits; private)	2	.1	3	.2
Railroad rights-of-way (private)	4	.2	4	.2
National parks and monuments (public) [2]	7	.3	32	1.7
State, county, etc., parks (public) [3]	3	.2	10	.5
Swamps, tidal marshes (private) [4]	5	.3	0	
Bird refuges	1	.1	17	.9
Game refuges			21	1.1
Roads (public)	[5] 19	.9	20	1.1
Total	53	2.8	121	6.4
III. LANDS OF LITTLE OR NO USE				
Desert lands (not grazed):				
Public domain (public)	33	1.7	32	1.7
State lands (school grants; public)	3	.2	3	.2
Indian reservations (not irrigated; public)	4	.2	4	.2
Death Valley monument (public)	2	.1	0	
Railroad grant lands (private)	5	.3	5	.3
Rocks and barren land	20	1.0	6	.3
Swamps and tidal marshes (not used):				
Private	3	.2		
Public	6	.3	2	.1
Beaches and dunes (not used; private) [6]	1	.1	1	
Total	77	4.1	53	2.8

[1] See footnote 1, page 112.

[2] Much of this area is forested or grassed, but no lumbering or grazing is permitted.

[3] Wildlife protection on much of it, but practically no lumbering or grazing is permitted.

[4] Used for hunting and trapping, with limited seasonal grazing in places.

[5] There are also probably between 1 and 2 million acres of former land surface now inundated by artificial reservoirs.

[6] The limited areas of valuable beaches are included in the urban area.

Shifts in Agricultural Land Use

In general, the best land is selected for the most productive use, which, among the agricultural uses, means for crops. Land less suitable for crops is used for pasture (except pasture in rotation with crops), and land less suitable for pasture is used for forest, where the climate permits. The trend prior to 1920 was toward an increase in the crop area. Until about 1850 this increase resulted mostly from the clearing of the forest, and after 1850 to an increasing extent from the plowing up of the native grassland pastures. (See fig. 11.) The production of the 413 million acres of crop land in the

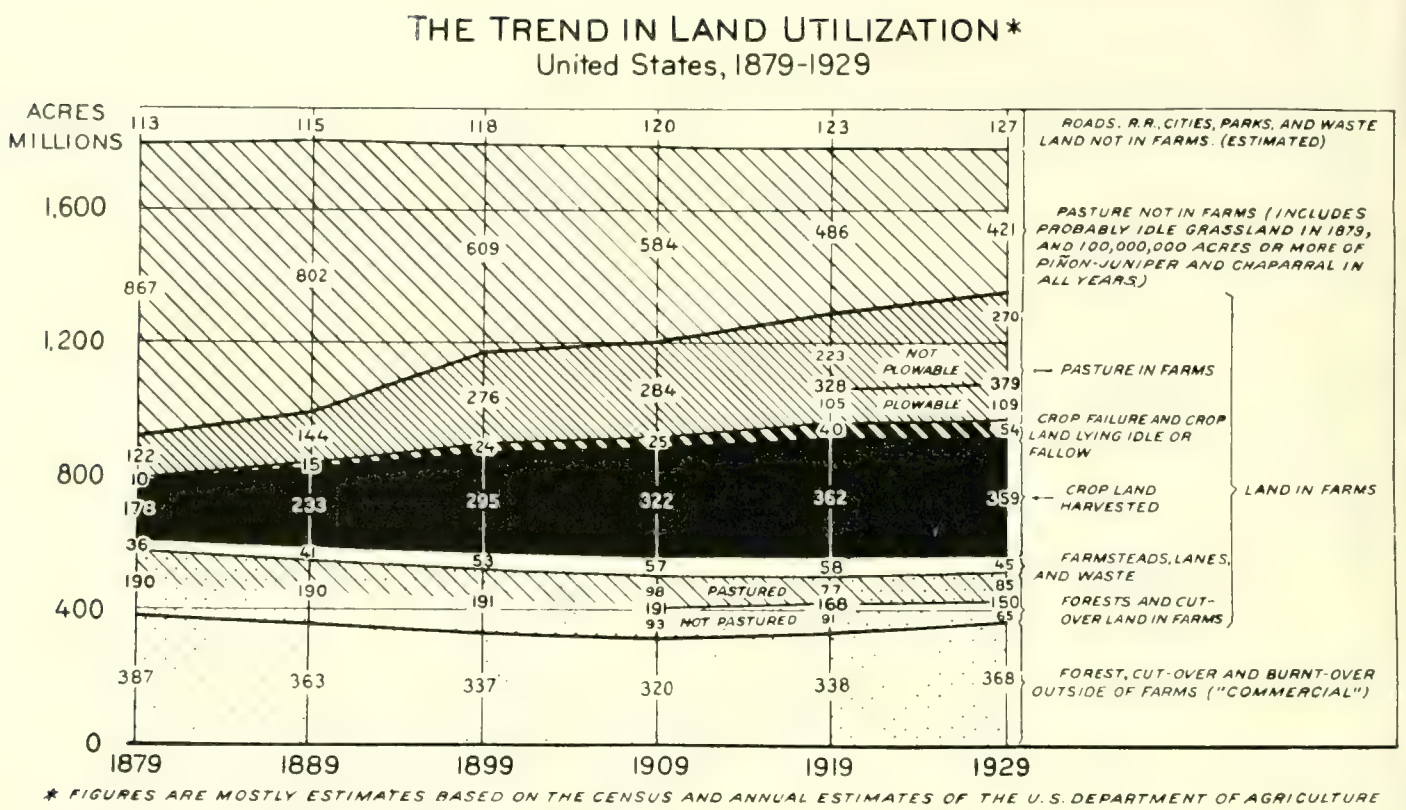

FIGURE 11.—The agricultural conquest of the continent is over. Although there is nearly as much tillable land still available as that now tilled, this land is mostly too dry or too wet, too steep or stony or sandy, to cultivate profitably under present conditions, or those likely to arise in the future. Between 1879 and 1919 the acreage of crops doubled, but between 1919 and 1929 it decreased 3 million acres—the first decrease recorded by a decennial census. A tendency to include less forest and cut-over land in farms may be noted, a rapid increase in crop land lying idle or fallow, and the inclusion of much former range land within the farm pasture acreage in 1919 and again in 1929.

census year 1929, including crop failure and idle or fallow crop land, was probably 3 times that of the 708 million acres of nonforested pasture and range land, and probably 4 times that of the 615 million acres of forest land of all kinds.

Conversely, when land becomes less suitable for crops, because of erosion or other losses of soil fertility, or for other reasons, it tends to be used for pasture, and should use for pasture become unprofitable it is permitted to grow up to forest, where the climate favors forest growth. Such a retreat of agriculture has been taking place in certain parts of the northeastern United States for many years, and after 1920 it became general in the eastern, originally forested, portion of the Nation. Between 1919 and 1929, according to the census, a net decrease in crop land (harvested) of over 33 million acres occurred in 1,940 counties, located mostly in the East and South. (See fig. 12.) Simultaneously an advance of agriculture occurred in the Great Plains region and locally elsewhere. Here, in 1,130 counties, a net increase occurred in crop land (harvested) aggregating over 30 million acres. (See fig. 13.) No comparables tatistics are available for the years since 1929, but there has been, no doubt, a considerable decrease recently in the crop area in the Great Plains region.

Such contractions in the agricultural area entail hardship and disheartening struggle. They are due in part to serious mistakes in the initial selection of land for settlement, but perhaps even more to deterioration of the land through misuse. As indicated elsewhere in this report, probably 35 million acres formerly in crops have been so greatly damaged that they are no longer cultivated. (See p. 161.) In other cases the soil is of low fertility inherently, and this fertility has been depleted by leaching and by the removal of the calcium, phosphorus, and other elements in the crops, and in the milk, bones, etc., of the animals sold. Millions of acres now in crops are inherently so inferior, or involve so much labor for cultivation because of topographic conditions, as to hold out little or no hope that they can ever be made, without unreasonable expense, to yield a decent living. (See pp. 175–184.)

Lands Proposed to be Withdrawn from Agriculture

A preliminary survey indicates that about 450,000 farms, including 75 million acres of land, should be withdrawn ultimately from arable farming in order that both the natural and the human resources of the Nation may be conserved. This farm land consists of about 20 million acres of crop land, 35 million acres of pasture

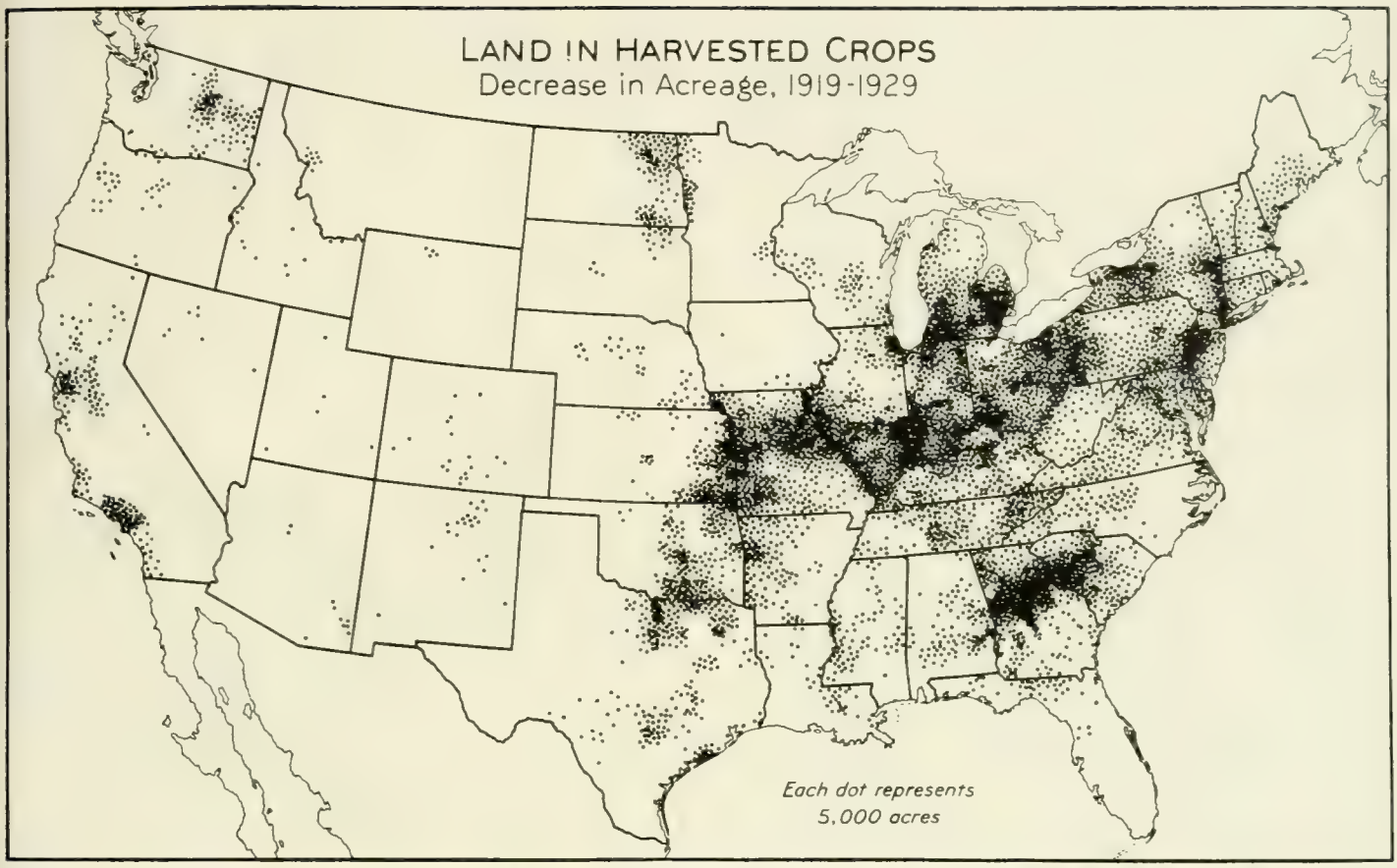

FIGURE 12.—A decrease in acreage of crops occurred between 1919 and 1929 in most of the originally forested portions of the United States. The decrease in the 1,940 counties reporting a decrease exceeded 33 million acres. The outstanding decrease was in the Piedmont of Georgia and South Carolina, and in a belt extending from southern New England across New York, southern Michigan, Ohio, southern Indiana, southern Illinois, and most of Kentucky and Missouri, to eastern Oklahoma and central Texas. Part of this land was used for pasture, part lay idle, and part was growing up to brush. The farms in these areas generally are small, and the soils are poor or fair, but some are good. Erosion was a large factor in the decline in crop acreage in the Piedmont, Ohio Valley, and Missouri areas.

land, and 20 million acres of forest and woodland, waste, and other land. In many cases purchase by the Government will probably be necessary to alter this use of the land or to facilitate the resettlement of the farmers in more favorable situations. Some of the crop land purchased may be sold for use as pasture, under restrictions, or be retained in Government ownership and used for pasture under a permit system, as in the national forests at present, or leased, as is now done by several States. Other crop land, mostly in the East and South, should be restored to forest, and some of the pasture land also, particularly where erosion is severe as a result of the steepness of the slope or character of the soil. In preparing table 2 and figure 10 it has been roughly estimated that 10 million acres of the crop land involved will be found best probably to use for pasture and 10 million acres for forest.

In addition to the 20 million acres of crop land described above, there are probably 5 million acres of crop land which it appears desirable to replace by farm pasture, in some places to control erosion, in other places to alter the system of farming so it will be better adapted to the climatic and soil conditions. The farms affected by this 5-million-acre program will continue to produce crops on land adapted to crops, but the conversion of some of the crop land to pasture or forest will in most cases involve enlargement of the farms. This occasionally may require purchase by the Government, consolidation of farms, and resale.

New Lands which will be Required for Crops

The population of the United States continues to increase, though much more slowly than in the past. It is estimated that the 20 million increase in population, more or less, between 1930 and 1960, and the modest increase expected in exports of farm products, will jointly require about 27 million acres more crop land than were harvested in 1930. It seems probable, judging from the past, that the increase in crops harvested will be accompanied by a proportionate increase in crop failure and crop land lying idle or fallow. This will increase the total area of additional crop land needed to 30 million acres. Since 25 million acres are recommended for removal from crop production, about 55 million acres of new crop land may be needed. As the new land to be brought into use for crops will be more

productive than that reverting to other uses, it is probable that the acreage needed may be less than this.

Where will the additional acreage of new crop land be obtained? It seems very probable that the acreage of irrigated land will increase by 3 million acres, perhaps more, by 1960; and probably 10 million acres or more land, unfit for crops at present, will be drained. Most of this is now covered with timber. Ten million acres of forest or cut-over land, perhaps more, may be cleared, judging from the fact that over 4 million acres of woodland in farms were cleared between 1920 and 1925, according to the census. But more than half the crop land needed, or about 32 million acres, will come, probably, from plowable pasture in farms.[1] This is only as large an acreage as was plowed up and put into crops in the single decade 1920 to 1930. In the three preceding decades the acreage of pasture plowed up for crops probably was greater.

This loss in pasture acreage will be recouped in part by reversion of some of the eroding and other crop land to pasture, where the climate is not suitable for forest. There need be no decline in the sustenance supplied by pastures, however, for the carrying capacity of most pastures is now low, and could be considerably increased—in the West by better management of the range particularly, and in the East by the use of fertilizers, as well as by better management. The experience of many farmers, as well as the experimental evidence, has clearly shown that the productivity of pastures can be greatly increased, and that generally it is profitable to do so. On some of the other land leguminous and other feed crops will be substituted for less productive pasture in order to provide the necessary supply of feed.

[1] This is a residual figure. Readjustments may be expected between crop land and plowable pasture as greater quantities of agricultural produce are demanded. It is possible that these may take the form of a reduction in the amount of idle crop land and the use of higher yielding legumes to provide hay and pasture for livestock and to maintain soil fertility, with a smaller total acreage devoted to these crops.

Forest, Recreation, and Wildlife Lands

The area of forest and woodland, it is expected, will remain about what it is today—a little over 600 million acres. However, judging from the trends during the past quarter century, there will be less forest and woodland in farms and more in Federal and State forests; but with a large acreage remaining in private ownership—perhaps 125 million acres in addition to the 124 million acres, more or less, in farms. (See p. 209.)

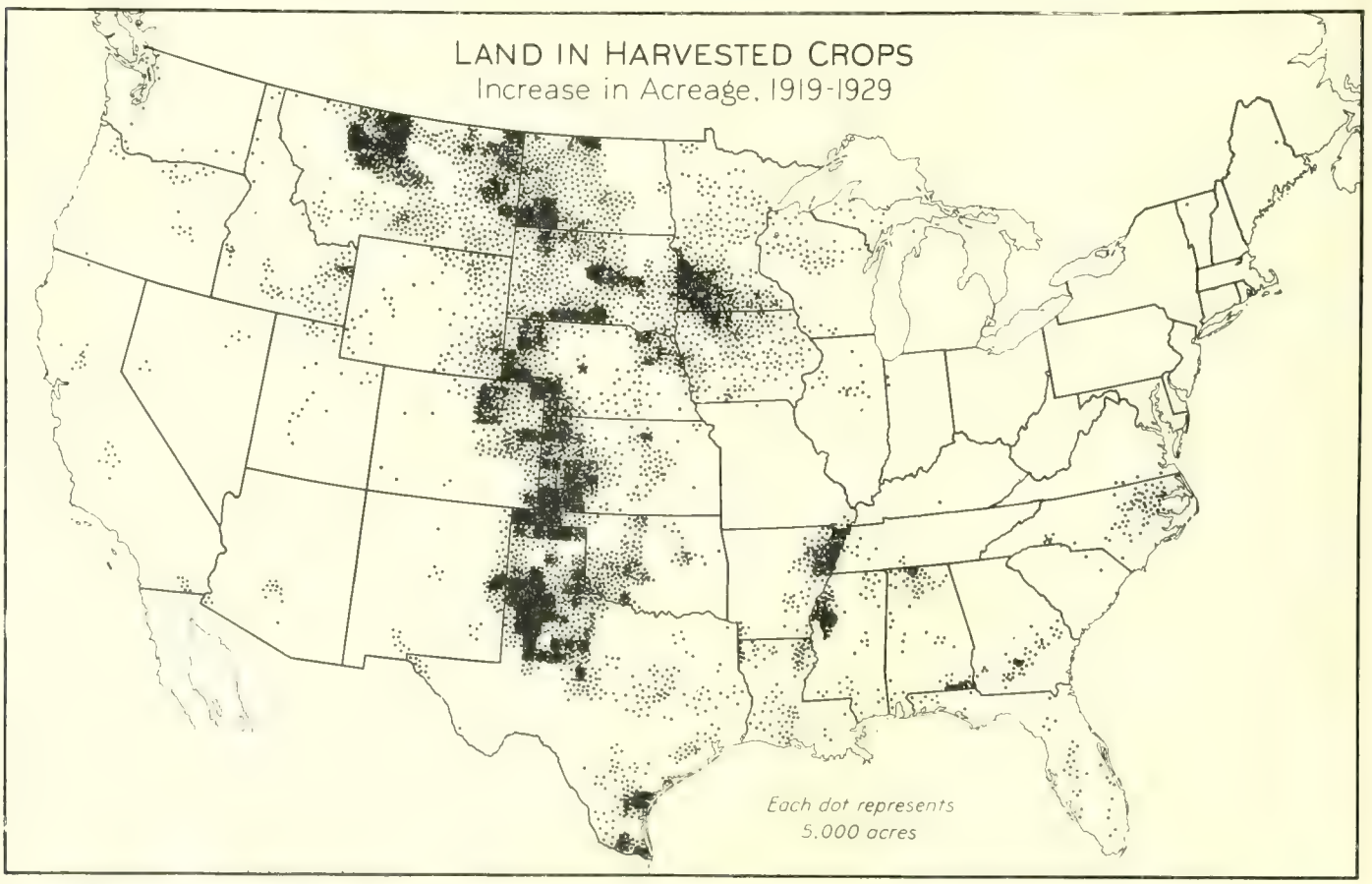

FIGURE 13.—The increase in crop area between 1919 and 1929 occurred mostly in the semi-arid portion of the Great Plains region, where the tractor, combine, and other labor-saving machinery made it possible to grow grain on the level land profitably at the prices then existing. A notable increase occurred also in southwestern Minnesota and in the Mississippi River bottoms of Mississippi and northeastern Arkansas. In both these areas much land had been drained, but most of the Minnesota gain was because of a severe drought in 1919. The increase in the 1,130 counties in the United States reporting an increase during the decade exceeded 30 million acres.

Almost certainly there will be a large increase in the acreage of land used primarily or secondarily for recreational purposes. It is suggested that the area in national parks and monuments be increased to 32 million acres. (See fig. 10.) Some of this land may be transferred from the public domain, some may be the mountain peaks in the Rocky and Sierra-Cascade ranges, consisting of bare rock mostly, and some will have to be purchased—small areas of extraordinary scenic value, or convenient to urban centers, or areas needed for blocking up administrative units. It is suggested that State and county parks be increased to 10 million acres. Much of this would be forest and cut-over land reverted to the State for taxes, but doubtless some land would need to be purchased. It is proposed that migratory bird refuges, mostly marshlands having little or no use at present, be increased to 17 million acres; and upland game refuges, to be derived in large part from the public domain in the West, be increased to 21 million acres. Municipal parks and parkways may increase by 1 million acres, and golf courses and country-club grounds by another 1 million acres. This increase would be almost equal to the present area.

There is enough land in the United States for all these uses, provided the necessary steps are taken to put it to the proper uses and to conserve its usefulness. At present the productivity of crop land, as well as pasture land and forest land, apparently is declining. Erosion is taking a heavy toll, while on some lands where erosion is slight, crop removal and leaching are depleting the fertility of the soil because of the relatively slight restoration of the essential elements by means of fertilizers. (See p. 163.) The carrying capacity of the pasture land apparently declined notably between 1919 and 1929. (See p. 124.) The total cut of timber for all purposes at present is about twice the annual growth. But under good management the present forest area could permanently supply a greater per capita consumption of wood than at present for a population considerably greater than at present.

The people on poor land are becoming poorer, whereas wealth should increase from generation to generation. In recent years farmers on good land have been growing poorer also. The soil losses by erosion and in other ways, the decline in crop yields per acre—slight as yet but clearly suggested by the statistics—the decrease in the carrying capacity of the pastures, and the depletion of the forests indicate that the agricultural resources of the Nation as a whole are declining. But these resources are restorable, except the soil lost by erosion. It is the purpose of this report to offer a general program for such restoration. The Nation's probable need for land in relation to the land resources will now be considered in more detail.

SECTION II

II. AGRICULTURAL LAND REQUIREMENTS AND RESOURCES*

The prospective land requirements for agricultural production depend on a number of factors. One of these is the outlook for population, which has already been considered. Other factors now to be considered are probable trends in per capita consumption, in exports and imports of farm products, and in the productivity of our crop and pasture land.

Consumption Factors Affecting Agricultural Land Requirements

Foods constitute 80 to 90 percent of the farm value of agricultural production. Of all food consumed by the American people, animal products (meat, milk, poultry, and eggs) represent fully two-thirds of the value at the farm, scarcely two-thirds measured by retail value, and less than two-fifths of the calory value. To produce these animal products, including allowance for mill feed, requires about three-fourths of the crop land used to produce food, directly or indirectly. Because of the large loss of sustenance in the conversion of grain and other feed into meat or milk, extensive substitution of plant foodstuffs for animal products would greatly reduce the acreage needed to feed the American people, and, conversely, an increased use of meat and milk would expand the acreage required.

Several outstanding changes in diet have occurred since the beginning of this century, the most important of which from the standpoint of land use has been the decline in the use of cereal foods. The total per capita consumption of all cereals apparently has decreased from about 380 pounds at the beginning of the century to 330 pounds before the World War and to 250 pounds in recent years. Most of this decrease has been in wheat flour (from 225 pounds about 1900 to 207 during 1909–13 and 173 in recent years) and in corn meal (from about 100 pounds in 1900 to 66 pounds during 1909–13 and 26 pounds on the average for 1929–33). (See fig. 14.) Had the per capita consumption of 35 years ago persisted, over 20 million more acres of cereals than at present would be needed to feed the American people, and had the pre-war per capita consumption been maintained, over 15 million more acres would be required.

As a partial substitute for decreased cereal consumption we have increased our per capita consumption of sugar from about 60 pounds around the year 1900 to 78 pounds during 1909–13 and about 98 pounds during the past decade. (See fig. 14.) However, consumption fell to 95 pounds in 1932–33. But since the area devoted to sugar crops in the United States is only about 1 million acres (three-fourths of the sugar consumed coming from Cuba and the insular possessions), the increase in acreage required for the larger use of sugar is insignificant compared with that involved in the decline in use of cereals.

Nor is the decrease in per capita acreage required for cereal foods counterbalanced by an increase in use of meat. The per capita consumption of beef and veal at the beginning of the century, also the average during 1909–13, was over 70 pounds, and of pork was about 60 pounds. Now these figures are practically reversed. Totaling the meats (including 5 to 7 pounds of lamb and mutton, but excluding lard and poultry), it appears that there has been a decline in per capita consumption from an average of about 140 pounds at the beginning of the century, and also during the 5-year period preceding the World War, to about 134 pounds during the last 5 years. This decline, however, may be owing in large part to the lower stage in the cycle of production during the more recent period. The shift from beef toward pork has had relatively small influence on the crop acreage required to produce the meat supply but has notably reduced the pasturage needed.

A shift has occurred also from apples toward citrus fruits and grapes, but the total consumption of fruit per capita has remained more or less constant, and the acreage required to produce the larger quantities of citrus fruits and grapes is probably not as large as would have been needed to produce the former larger consumption of apples. The use of many kinds of vegetables has increased, but the acreage of land involved in this increase is very small and is little more than that involved in the decreased per capita consumption of potatoes.

Milk and its products, which constitute the most important food in the American diet, measured in crop acreage required for production as well as in value, apparently changed little in per capita consumption

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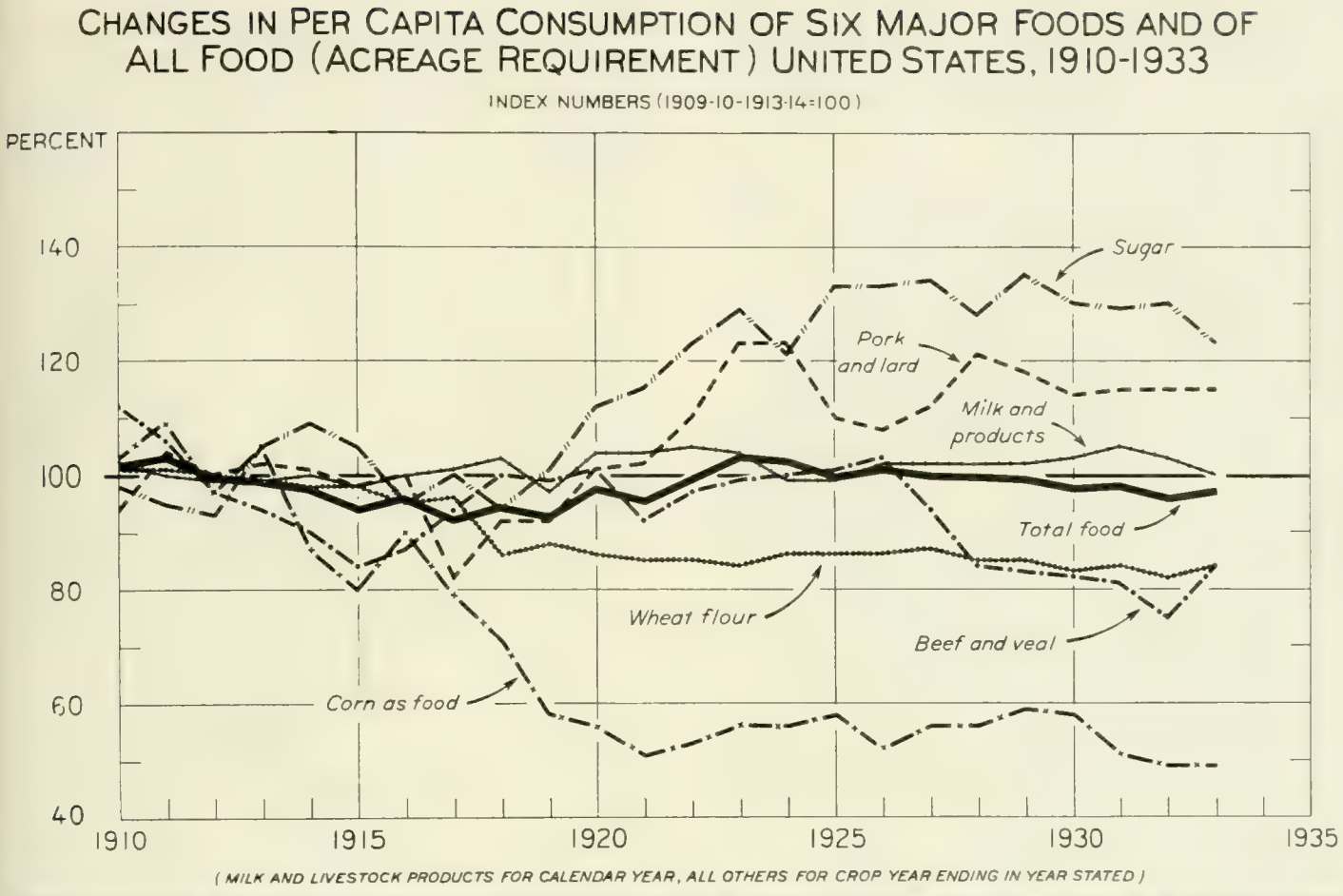

FIGURE 11 The World War restrictions, the prohibition amendment to the Constitution, the prosperity of the urban people during and after the war, and other influences worked significant changes in the diet of the American people. The per capita consumption of corn for human food apparently dropped one-half between 1913 and 1921 and of wheat about one-sixth, mostly between 1917 and 1918; while the per capita consumption of sugar increased a third between 1919 and 1925, and of pork and lard about a fourth between 1919 and 1923. The curve for beef and veal shows a cycle 17 years in length, with a slightly downward trend, but the per capita consumption of milk and dairy products has been well maintained. Combining all the foods, it appears that normal acreage required for production of the diet was about as large per person prior to the depression as prior to the World War, but that there has been a slight downward trend since 1923.

between the pre-war years and the pre-depression period. The per capita production of milk, practically all consumed in the United States, was about 777 pounds in 1909 and about 809 pounds in 1929, according to computations based on the census; but owing to the shift in date of enumeration from April 15 to April 1, it is probable that actual increase in production per capita was somewhat larger. Comparing the estimates of milk consumption for the 5-year periods centered on these two census years, it appears that the per capita increase was 4 to 6 percent. This increase would require about 2 million acres of crop land for its production. Prior to the depression there was an upward trend in urban consumption of milk per capita, but the trend was largely offset by the trend of migration of population from the country, where per capita milk consumption was high, to cities, where, in spite of the gradual increase, it was relatively low.

Butter consumption has fluctuated between 17 and 18 pounds per person for many years, except that during the World War and for a few years afterward it ranged from 14 to 16 pounds. Cheese consumption has ranged from 3 to 5 pounds and has been higher in recent years. Whole milk, cream, and ice-cream consumption increased in the cities during the decade of urban prosperity after the war. From 1923 to 1929 the increase was nearly 7 percent. But from 1929 to 1933 consumption fell 5 percent. With the return of prosperity it is to be hoped that the upward trend will be resumed. However, it must be recalled that beer now competes more or less with milk as a beverage.

Totaling the per capita crop acreage normally required to produce these and other foods (on the basis of the yield per acre during 1923–32), it appears that there was no material change in aggregate acreage per person between the 5-year period preceding the World War and the 5-year period preceding the depression. Measured in calories of energy provided by the diet, the decline apparently was about 3 percent from 1909–13 to 1925–29 and somewhat more during the depression. Most of the decline was accounted for by wheat and corn, with a little decline in milk and poultry products during the depression. Doubtless the principal explanation of the decline in cereal consumption, as compared with pre-war years, lies in the decreasing proportion of the people engaged in outdoor or manual

labor. However, the important fact is the very slight change that has occurred in aggregate consumption of food per person. The farmers continue to produce in depression as well as in prosperity, and the people continue to consume.

The trend in per capita consumption of cotton in the United States remained remarkably steady for 30 years prior to the depression at about 25 pounds. Increasing industrial use counterbalanced the declining use for clothing. In the year 1931–32 per capita consumption fell to 17 pounds, but during the year 1932–33 it rose to 22 pounds. The per capita consumption of tobacco increased little, if any, from the beginning of the century to the beginning of the World War, then rose during the war, decreased 20 percent after the War, and remained more or less constant afterward until 1929. Since 1930 consumption has decreased to about 10 percent less than in 1929. The per capita consumption of flaxseed, used mostly to produce linseed oil, declined from the pre-war period 1909–13 until 1917–18, then rose rapidly to a peak in 1928–29. Consumption has declined rapidly during the depression, doubtless owing largely to lesser use in paint, and may be expected to increase again as building activity is restored.

Looking forward to the next 25 years there are only two factors affecting the domestic consumption of farm products that can be foreseen with reasonable certainty—the gradual approach to a stationary and probably later to a declining population in the Nation as a whole, previously described, and the change in age composition of the people. Since 1930 the number of children under 5 has decreased about 11 percent, and of children 5 to 10 years old about 9 percent, while the elderly continue to increase. Several recent studies indicate that children consume 50 to 100 percent more milk per capita than adults.

If by 1950 there are 15 percent fewer persons under 20 years of age than in 1930, and 65 percent more people over 65 years (the increase from 1920 to 1930 was 34 percent, and a similar increase must continue for several decades), and assuming a per capita consumption for persons under 20 years of age 50 percent greater than for those 20 to 65 years of age and 100 percent greater than for those over 65 years, there may be a decrease in per capita consumption of milk during these 20 years, other factors remaining equal, of 3 to 4 percent. This would be merely an accentuation of a tendency that has long prevailed but so far has been offset by other factors. It appears probable also that children eat more eggs than adults. On the other hand, the use of cereals and many other foods by children is probably considerably less than by adults. Since adults will constitute an increasing proportion of the population for at least several decades to come, it appears probable that the per capita consumption of cereals, sugar, meats, and the fats, and, to a less extent, of the vegetables and fruits, will continue to increase for some years, even should the population of the Nation begin to decrease.

Moreover, fewer children in the future should help many families to maintain a higher standard of living, including the use of the more expensive foods—meats, fruits, and vegetables. In particular, it may be hoped that the use of milk will increase. In a study of diets at four levels of income, the Bureau of Home Economics recommended the use in both the "adequate diet at moderate cost" and the "liberal diet" of about twice the present per capita consumption of milk. There are millions of people in the cities, and millions more on farms, particularly in the South, who greatly need better food. Their health and efficiency undoubtedly could be materially improved by adequate nourishment.

Yet the fact remains that despite a declining size of family for many years in the past and advancing per capita income in the cities prior to 1930, consumption per capita of the meats, as a whole, and of the fruits did not increase, while the increase in use of milk apparently did little more than restore the slight loss that occurred during the World War years. During these years a much greater decline occurred in the use of the cereals, and if the proportion of the people engaged in outdoor employment continues to decrease, it is possible this trend may continue. It appears more likely that the per capita consumption of the cereals has, during the past decade, reached a new level which will be fairly well maintained. With reference to per capita consumption of farm products as a whole, as measured by per capita land requirements, the safest assumption appears to be that the remarkably stable conditions which have characterized the past quarter century will continue for a quarter century to come. The domestic consumption of farm products, should no great effort be made to alter the diet or influence the consumption of the nonfood products, probably will vary primarily with the changes that may occur in the population of the Nation. If the purchasing power of the mass of the workers should be increased materially, however, the consumption outlook might be materially altered.

During the past decade (assuming the average acre-yield of each crop for the decade), it has required about 1.9 acres of crops per person to feed the people of the United States, including seed, but excluding the diminishing acreage needed to feed the horses and mules used in producing these farm products. To produce the nonfood farm products consumed by the people has required 0.2 acre of crops per person. Domestic consumption of farm products per person, excluding the acreage needed to feed the horses and mules, has required, therefore, during the past decade about 2.1 acres of crops. To this should be added about 0.4 acre per person (1933) required to produce feed for the

horses and mules used in producing for domestic consumption. In other words, nearly 2½ acres of crops are required to provide farm products for the average American at present. If the number of horses and mules continues to decline, this acreage will, probably, become less, but should they increase the acreage will rise.[1] It takes more land to feed a horse than it does a human being.

To produce the "adequate diet at moderate cost" suggested by the Bureau of Home Economics, would require about 1.86 acres of crops (exclusive of land required to maintain the requisite work stock) per person. It is obvious, however, that many people consume the products of more than this acreage, while others consume less. The suggested "liberal" diet would require 2.3 acres per capita. An important future task is to aid the people submarginal in diet in obtaining the food they need.

Outlook for Exports and Imports of Farm Products as Affecting Land Requirements

Exports: The amount of crop land devoted to farm products exported from the United States has been roughly estimated at about 63 million acres[2] on the average during the period 1925–26 through 1929–30. About 47 percent of this was accounted for by cotton and 26 percent by wheat. Among other agricultural exports, tobacco and fruit, being highly intensive crops, require much less land in proportion to the value of the products exported than other commodities, and their importance from the point of view of acreage alone is small. Their significance is rather in connection with the utilization of labor in agriculture. During the present depression United States agricultural exports have diminished greatly, and in 1933–34 accounted for only about 39 million acres of crops.[3] An index of the quantity of agricultural products exported shows a decline of 37 percent from the average of 1925–26 through 1933–34.[4] (See fig. 15.)

The decline of agricultural exports during the depression has been due not only to the increased severity and number of trade barriers and to the reduced purchasing power of countries importing American farm products, but also to increased competition from other sources. Most of our principal agricultural exports have been displaced in some degree by exports from other countries as well as by increased production in importing countries. In the future development of our export trade the competition of other exporting countries is likely to be somewhat more important than in the past, and will require as much attention as the demand of importing countries.

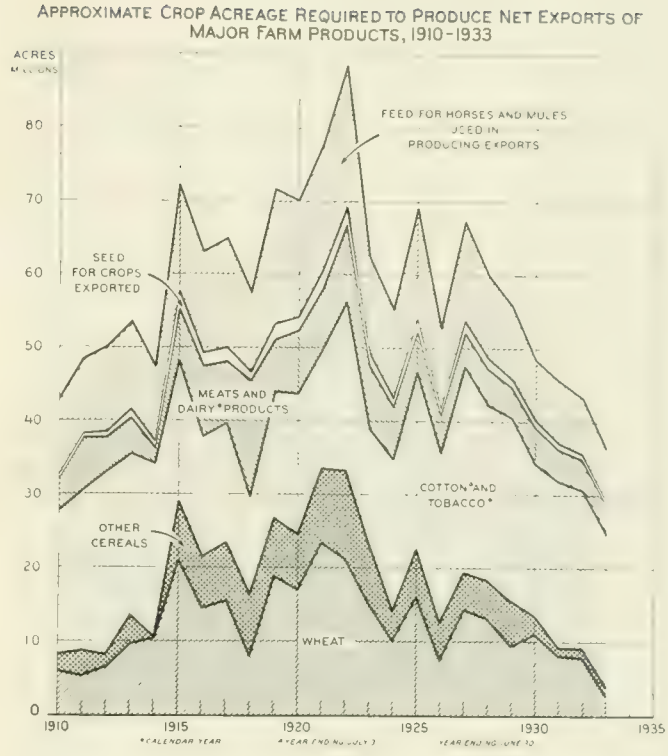

FIGURE 15.—The acreage required to produce the net agricultural exports from the United States reached a peak about the beginning of the century and again during the years 1919–22. From the high point of over 80 million acres in 1921–22 the area declined to less than 40 million acres in 1932–33. This was lower even than in the year 1909–10. Cotton, including the estimated acreage needed to grow the feed for horses and mules used in production, has required one-half to two-thirds of the total acreage in recent years, while wheat, which formerly constituted about one-quarter of the total has fallen to less than one-fifth.

Both foreign competition and foreign demand are matters concerning which any forecast is inherently difficult. Partly this is on account of the many uncertainties over which the United States can at best exercise little, if any, influence. But partly also it is because of the potential factors within the control of our own Government which can and ought to be put to effective use. If, for example, the present policy of making trade agreements with foreign governments is vigorously and successfully pursued, our agricultural exports should, over the next decade or two, be much larger than they otherwise would be. By reducing foreign trade barriers, the making of trade agreements can increase the demand of importing countries for our agricultural products, and also increase foreign purchasing power for our products. Moreover, it can increase our ability to compete with foreign countries by reducing our own tariff duties and restoring a satisfactory equilibrium in our balance of international payments. For many years our imports of goods and services have not been sufficient to pay for our exports. The balance has been met mainly by exports of capital [5]

[1] The 1934 outlook report of the United States Department of Agriculture indicates that the number of work stock will continue to decline until late in 1936, but that after that time there probably will be some increase.

[2] Estimates by Production Planning Section, Agricultural Adjustment Administration.

[3] Preliminary estimates by Production-Planning Section, Agricultural Adjustment Administration.

[4] Calculated by the Bureau of Agricultural Economics. This index number, in which the quantities of various commodities are weighted on a value basis, is not comparable with calculations based on acreage requirements.

[5] During the depression years there has been a large export of short-term capital, making a net export of all capital, although net exports of long-term capital were converted into net imports after 1930.

and recently by silver purchases. The difficulties of foreign countries in obtaining dollar exchange to pay for American goods have led some to adopt special trade barriers and compensation agreements which hamper our trade, and led others to reduce their costs, partly through exchange depreciation, thus intensifying the competition of their export industries with American industries. Such obstacles to our trade can be greatly reduced by modifications of our tariff which will permit a substantial increase of imports.

Recovery from the depression, both in the world as a whole and in the United States, should greatly facilitate the success of efforts to reduce trade barriers, and can, conversely, be greatly stimulated by the reduction of barriers. Recovery will also affect our agricultural exports independently of trade barriers. During the next few decades there seems to be no reason for supposing that the aggregate production and real incomes of the world's populations will not continue to increase as they have in the past. As regards the outlook for the next few years, the world is now on its way out of the depression and the analogy of past depressions makes it appear likely that recovery will continue. In many of the less developed countries of the world, and in Japan, industrial expansion has continued despite the depression. Prospects for industrial conditions will, of course, depend very largely on political developments. Trade barriers and the fear or actuality of war may considerably hamper the revival. It has been necessary to assume in this section that no major war will take place during the period to which our forecasts refer. This assumption is dictated primarily by the fact that the world situation will be unpredictable in the event of a war. Despite the constant talk of war, however, there are persuasive reasons, which cannot be gone into here, for thinking that a major war in Europe will be avoided.

Increased purchasing power and lowered trade barriers offer real possibilities of substantial improvement over a number of years. It is likely that general economic recovery will result in a wide-spread reduction of trade barriers, for the same reasons as those which explain their intensification during the depression. The policy of making liberal trade agreements need not be confined to the United States. For the next 2 or 3 years a limited improvement in regard both to trade barriers and business conditions is to be expected.

In addition to the general prospects, certain special conditions affecting American agricultural exports must be considered. Foreign competition has been increased in recent decades by the utilization of natural resources in countries that have developed later than the United States. In wheat, Canada, Argentina, and Australia have gained relative to the United States. Possibilities of a similar development, though on a much smaller scale, exist in the case of cotton in South America. In the case of fruit and tobacco, foreign competition is being fostered both by the development of new resources and the use of technical methods which are new in some foreign countries but not new in the United States. In the face of such developments this country can check the displacement of its agricultural exports by those of other countries only by continuously improving the efficiency of its own production. Mechanization, which has enabled the United States to retain a position in the world wheat market, may also help to maintain our competitive position in the case of cotton. The prospects in regard to these matters vary greatly from one commodity to another. The statements made below in regard to particular commodities are based on the assumption that it will continue to be the policy of the Government to encourage efficiency in agricultural production.

In connection with the demand for farm products in importing countries, population prospects constitute a limiting factor in the case of some products. The population of Europe, which during the 30 years from 1880 to 1910 increased by around 28.2 percent, will probably increase from 1930 to 1960 by around 13 percent.[6] The populations of northern, central, and western Europe will almost certainly sooner or later reach a maximum, after which there will be a tendency to decline. In the British Isles the maximum may be reached around 1936; in France, by 1935, unless immigration should be resumed on a significant scale; in Germany, probably before 1945; in Belgium, apparently between 1940 and 1945; and in Italy, perhaps, by 1980. In the Scandinavian countries the population is likely to remain nearly stationary for a decade or more. The countries mentioned are those which take the bulk of our agricultural exports to Europe, while the more prolific populations of eastern Europe import little from this country.

The diminishing rate of population growth will tend after a few decades to limit the increase of consumption of staple foodstuffs and tobacco, although some important pos ibilities for increasing per capita consumption exist even in the case of such a commodity as wheat. So far as per capita real incomes and purchasing power are concerned, these should increase more rapidly with a slow rate of population growth than with a large one. Hence, the imports of semiluxuries, such as fruits, and agricultural products used in industry, such as cotton, may ncrease considerably even in countries with a stable population.

Finally, the rate of population growth and the rate of improvement in the standard of living are likely also to affect agricultural production in Europe. Insofar as the demand for labor and the level of real wages are increased, agricultural production may tend to be reduced, since the highly intensive methods of production that

[6] The latter figure does not make full allowance for emigration.

prevail in most of continental Europe (including agricultural countries on an export basis, such as Holland and Denmark) are possible partly because of a low rate of remuneration per hour of labor for those engaged in agriculture.

In view of the uncertain nature of the various influences likely to affect our agricultural exports, the statements made below in regard to prospects for individual commodities must not be egarded as predictions, but merely as estimates of future possibilities which, in the light of available information, appear to be plausible. In view of the uncertainties of the world market, it will be wise in formulating land policy to make plans as flexible as possible in order to provide for unforeseen developments.

While it is possible to take widely differing views of our export prospects, depending on the emphasis placed on each of the various considerations mentioned in the foregoing discussion, we feel that this Government should formulate its land policy so as to allow for the exports which could take place if a reasonably optimistic point of view should prove to be correct. This would seem desirable in view of the fact that this Government is making efforts to revive both international trade (particularly exports of farm products) and business activity.

1. Cotton: The prospects for cotton appear more favorable than for most of our agricultural exports. The United States can profitably produce cotton to sell at a lower price than can most other countries producing a similar grade. There are large new areas in foreign countries that could be devoted to cotton, but it is improbable that foreign production will be expanded enough to reduce greatly our export possibilities unless the price of American cotton is kept so high as to allow foreign growths to sell at a price which makes cotton raising in those countries more profitable than other agricultural pursuits.

There is reason to expect a substantial increase in world demand for cotton. Consumption has been increasing generally for many years and did not fall off very greatly in the world outside of the United States even during the depression. It is reasonable to assume a very considerable increase if progress toward better conditions throughout the world is substantial in the future.

Competition from rayon and other synthetic textiles is not as serious as might be inferred from the great increase in production of such products in recent years. Simultaneously, many new uses, industrial and other, have been found for cotton, which, considered in conjunction with the influence of growing populations and higher standards of living, promise to stimulate demand more than enough to offset losses in cotton consumption due to this competition.

Assuming that the policy of this Government with respect to cotton production will not be such as to cause the world price of American cotton to be disproportionately high as compared to foreign cottons, a reasonable basis for plans for the future would be that during the next 5 years exports of raw cotton and the cotton equivalent of yarn and cloth will average around 8½ or 9 million bales and increase slowly to 10 or 11 million bales within the next 25 years.

2. Wheat: There is no likelihood that the United States will be able, during the next 10 years, profitably to export the same quantities of wheat as before the depression, but there are, on the other hand, good reasons for maintaining that this country can and should expect to remain one of the major wheat exporting countries of the world.

Owing both to the existence of extremely severe trade barriers and to improvements in wheat production in European countries, European import requirements will no doubt continue for a number of years to be substantially less than they were before 1929. The production and exports of the four chief exporting countries (Canada, United States, Argentina, and Australia) will therefore also need to be smaller. Substantial acreage reductions in these countries, however, have already taken place, and the short world crop of 1934 is likely to result in the absorption of a considerable portion of the surplus stocks. In the next few years it is possible that world imports (and particularly European imports) will recover from their present low level sufficiently to permit a partial recovery of acreage and exports in the case of Canada, Argentina, and Australia and at least of exports in the case of the United States.

The possibilities of effecting a material change in the wheat policies of European governments through the tariff negotiations being conducted by our Government are less favorable than in the case of other commodities. Since the United States is not the world's principal exporter of wheat and supplies a relatively small share of the imports of European countries, it will be difficult to obtain concessions from foreign governments on this commodity under the most-favored-nation clause. Moreover, the willingness of European governments to make concessions in wheat is likely to be less than in the case of most agricultural commodities, because of the importance of wheat in their agriculture. On the other hand, if and when a movement for the substantial reduction of trade barriers through reciprocal agreements becomes generalized, some gradual but effective relaxation of European restrictions will be in prospect. Meanwhile, under the International Wheat Agreement, the importing countries of Europe are pledged to endeavor to increase wheat consumption and check further increase in acreage; and in the first year of the Agreement several manufacturing countries took active steps to carry out this pledge. Thus, while on the one hand the immediate prospects in regard to European trade barriers are not particularly favorable,

on the other hand the possibility of a significant improvement over a period of 10 or more years cannot be ignored.

There are two main regions in the United States which appear capable of producing wheat for export as cheaply as any other part of the world, namely the Pacific Northwest, and the hard winter wheat region (Kansas, Oklahoma, and Texas). For the purposes of land policy it seems reasonable to assume that exports from these two regions together should average at least 75 million bushels in the next few years, with a possibility of an export of around 125 on the average in about 10 years. Wheat produced in other regions probably will and should remain on a domestic basis, with the exception of durum wheat, which will probably be exported in small quantities.

3. Tobacco: The outlook for tobacco exports is particularly difficult to evaluate. Future prospects indicate a smaller rate of increase in foreign consumption than in the past. The possibilities of an increase in our exports depend largely on the success of our trade bargaining efforts. Tobacco is a commodity of which the United States is a principal source of supply to many importing countries. This is particularly so with respect to certain types, such as flue-cured tobacco. Moreover, tobacco is not an important commodity in the agriculture of most European countries, and hence the opportunities for obtaining concessions on our exports of tobacco should be relatively favorable. Should success in this direction be inconsiderable, our exports of tobacco during the next 5 years would probably not exceed a level of around 500 or 550 million pounds. With a substantial improvement in the trade barrier situation, our exports might be substantially higher.

4. Pork and Lard: The probable outlook for exports of pork products is of minor importance from the point of view of land policy. Our exports of pork meat are now so small as to be practically insignificant in comparison with domestic consumption. The prospects for a future increase in our exports of pork meat are very poor. The experience of recent years has shown that such countries as Denmark and the Netherlands can successfully compete with the United States and the development of subsidized pork industries in Poland and the Baltic countries makes the prospect even less favorable. For the present the policies pursued by the British Government make an increase of our exports to Great Britain improbable. Germany has now approximately reached self-sufficiency in regard to meat. This eliminates our two principal markets so far as any significant quantities are concerned. Lard, being a by-product, is practically eliminated as a significant export so far as land policy is concerned. Unless the lard content of the average hog in this country is substantially reduced, our exports of lard will be mainly determined by the domestic and export demand for pork meat. On the other hand, should it be possible to reduce the cost of producing the hog by economizing in feeding, which would reduce the lard content, this might be profitable, since the prospects for lard prices in export markets are not favorable. Some increase in hog-product exports may be expected to result from the Cuban treaty already signed, but this is relatively small in terms of corn acreage.

5. Fruit: During recent years fruit exports have increased considerably, while exports of most other agricultural commodities have either declined or remained stationary. Consequently, fruits, taken together, have become one of the most important items in our agricultural export trade from the point of view of value, ranking third after cotton and tobacco in 1933–34. From the point of view of land requirements, however, the importance of fruit exports is small, since fruit yields an exceptionally high value per acre. The competitive interrelationships of various fruits, produced in various parts of the world, are so complex that it is not clear what further increase, if any, is likely to take place in the exports of fruit from this country. It is clear, however, that our fruit exports will be faced with increasingly severe foreign competition in the next decade or two.

The above conclusions relative to the prospects for the gradual increase of the volume of agricultural exports assume that the United States will choose a policy of give and take in its international economic relationships, with due reference to promoting the interests of agriculture in the foreign market, rather than a policy of narrow economic nationalism, and will be successful in inducing other nations to collaborate in the first type of policy.

The figures based on this assumption, therefore, reflect a considerable measure of optimism which may not be realized in practice. It has been deemed well, therefore, in table 5 (page 126), to show the land requirements for agricultural export production predicated both on the assumption of a considerable restoration of foreign trade and on the assumption that no important changes occur in present conditions affecting international trade.

Imports: The major part of our imports of agricultural products does not compete with American agriculture. It consists not only of such things as silk, rubber, bananas, tea, coffee, and various other tropical products, but also of special grades of some commodities, such as tobacco, required to supplement our domestic production, and of imports of certain fruits and vegetables in seasons when they are not produced in this country in sufficient quantities.

Of those imports which do compete with the products of American agriculture, the most important are sugar, flaxseed, and wool. In the case of all three of these products the prospective requirements for domestic production depend almost entirely on our tariff and

quota policies. On the whole, all three commodities can be produced in foreign countries more efficiently than in the United States. In the case of sugar it seems probable that production in continental United States will remain substantially unchanged in the next few years. In the case of flaxseed some increase is likely to take place. Any reduction, however, in our imports of flaxseed is likely to increase competition of Argentina with the United States in wheat. Argentina is our principal source of supply for flaxseed, and wheat is the most important alternative product which could be grown on land from which flaxseed might be displaced in Argentina as a result of our tariff policy. In the case of wool no increase of production is in prospect. The United States has practically reached the point of self-sufficiency in those types of wool which are produced in this country. Domestic wool consumption in recent years has been approximately stable.

The elimination of competitive agricultural imports could at most provide a demand for the products of 10 to 15 million acres in this country. Against this, however, must be offset the reduced demand for acreage to produce exports which would result from any further restriction of our imports of competitive agricultural products. Such a result would take place not only because our imports supply foreign countries with a means of purchasing our exports, but also because in nearly all cases competitive agricultural commodities which we import compete in production or consumption with those which we export. An illustration of competition in production has been mentioned in the case of flaxseed, and one of competition in consumption may be found in the case of long-staple cotton. The effect of our tariff on long-staple cotton has been mainly to cause a shift in foreign consumption from American cotton to the foreign long-staple cotton which our tariff has excluded from the United States.

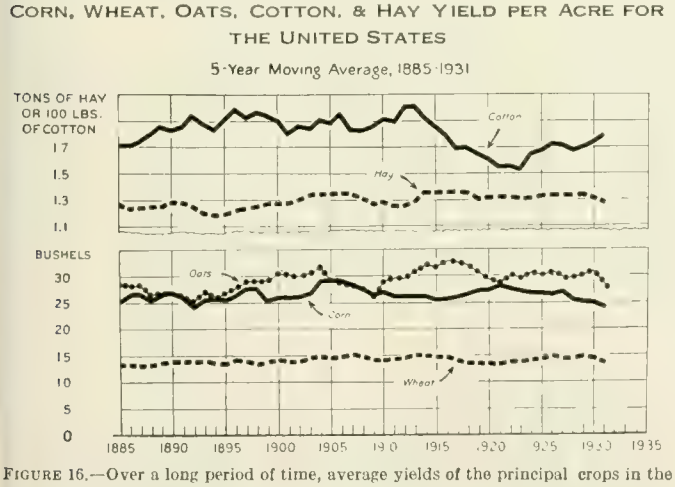

FIGURE 16.—Over a long period of time, average yields of the principal crops in the United States have been fairly constant. Over shorter periods, upward or downward tendencies have appeared, only to give way, as a rule, to an opposing tendency a few years later. The low cycle in cotton yields was due principally to the boll weevil, but the upward tendency recently is encouraging. In some cases the apparent upward or downward tendency is due largely to one or two exceptional seasons.

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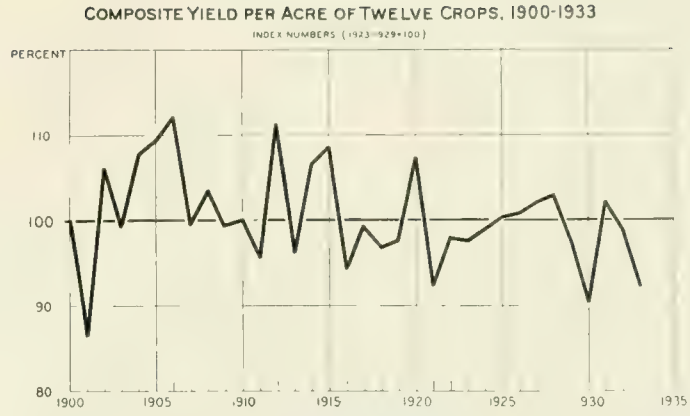

FIGURE 17.—Average acre yields were slightly higher in the early part of the century than during the past decade and a half. Over the latter period, however, aside from year-to-year fluctuations, the trend has been practically horizontal. Recent drought years, of course, have depressed yields.

Production Factors Affecting Agricultural Land Requirements

Changes in yields of particular crops or in the carrying capacity of land for the maintenance of livestock might also exert considerable influence on land requirements. A brief examination of the prospects in these regards, insofar as practicable, is therefore important.

The reported average acre yields of the two principal grains in the United States have exhibited a nearly horizontal trend from 1866 to 1933. In the first 10 or 15 years of the present century both wheat and corn averaged slightly higher yields than either before or since, but from 1916 until 1930 trends in yields of both crops have been practically horizontal. The recent drought years, of course, have depressed yields. (See fig. 16.)

The average yield per acre of tame hay has shown a horizontal trend since 1900. A continuation of this trend may reasonably be expected, and if dairying should increase in importance, yields might increase.

The trend in yield per acre of cotton since 1866 has been very nearly horizontal in the United States as a whole. From approximately 1915 to 1930 there was a cycle of low yields, attributable principally to the boll weevil, but in 1931, 1932, and 1933 the annual yields were approximately equal to the long-time trend. Individual States show considerable variation in trend, much of which follows the chronological path of the boll weevil across the South.

Tobacco exhibits great variation in yield both by types and by producing regions. However, since the yield of tobacco depends largely upon good care and growing conditions, it appears reasonable to expect continuation of present yields.

The trend in yield per acre of the minor crops, especially of truck crops, fruits, and vegetables, probably can

be controlled within reasonable limits by suitable fertilizer and farming methods.

Five-year moving average yields of principal crops since 1885 are shown in figure 16, and an annual index of composite yields of 12 important crops since 1900 is shown in figure 17.

Increased production through greater intensity of land use may take several forms. It may consist of increased yields per acre through improved seed, use of fertilizers, better tillage, and more effective eradication of insects and disease. While some countries of western Europe show much higher average yields for particular crops than we are accustomed to, it is significant that, as shown above, our yields of the principal crops have not increased materially for several decades. More recently the depression has exerted an influence adverse to the employment of commercial fertilizers.

Another form of increased intensity is through the substitution of intensive crops for extensive crops—for instance, growing cotton or vegetables on land formerly in corn or meadow. In general, it seems probable that we shall have to move in exactly the opposite direction, for, as shown later in this report, there are extensiv areas of good farm land now devoted to tillage crop which will have to be put into meadow or pasture or pasture rotation in order to check severe losses in soi fertility through erosion or other causes. The mos promising form of increased intensity of arable lan use is through the more efficient conversion of feed int livestock products. Through more scientific rationin and particularly through improvement of breeds an the culling of inferior animals, considerable economie in land use have already been effected and furthe economy may be expected. On the whole, the balanc of these various tendencies probably indicates that w should not count altogether on a notable increase o production through greater intensity of use of arabl land.

Trends in Area and Productivity of Pasture Land

In the North practically all the pasture land is in farms in the South this is also true of the nonforest pasture but there is much forest land outside farms that is use for grazing. In the West, however, where most of the land was originally grass covered or desert, about two-

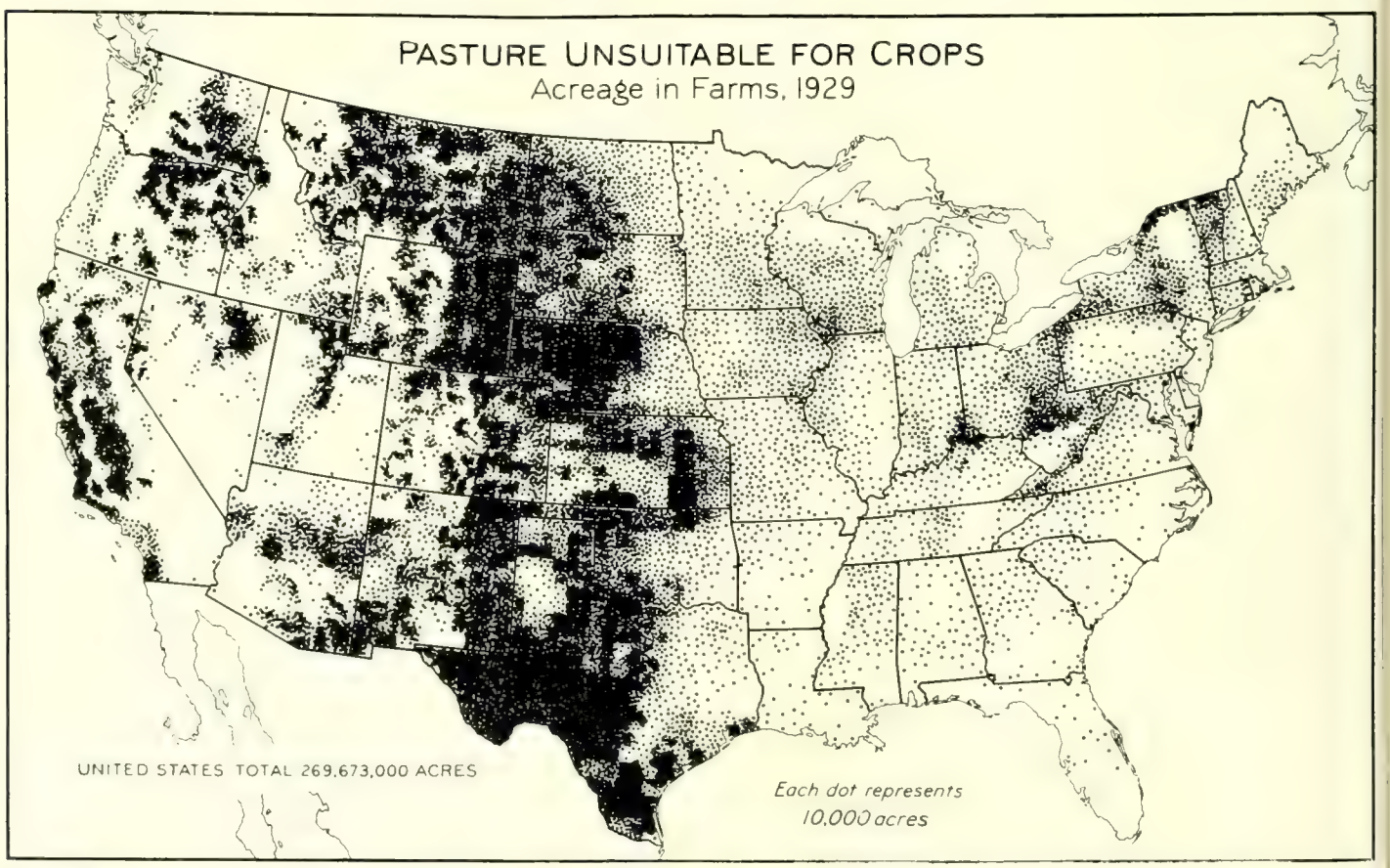

FIGURE 18.—Most of the pasture land in farms unsuitable for crops is located in the Great Plains region—former natural range land included within farm boundaries—but there are large acreages also in the Pacific Coast States and Arizona, in the upper Ohio Valley, in New York, and New England. A less dense distribution of such pasture is found in the Great Lakes States, Iowa, Missouri, and western Illinois. In addition to this pasture land in farms, there is much grazing land not in farms, principally in the western half of the United States. The aggregate of pasture, including range land in the Great Plains region and westward to the Pacific coast, is nearly 800 million acres, but most of this land is of low carrying capacity.

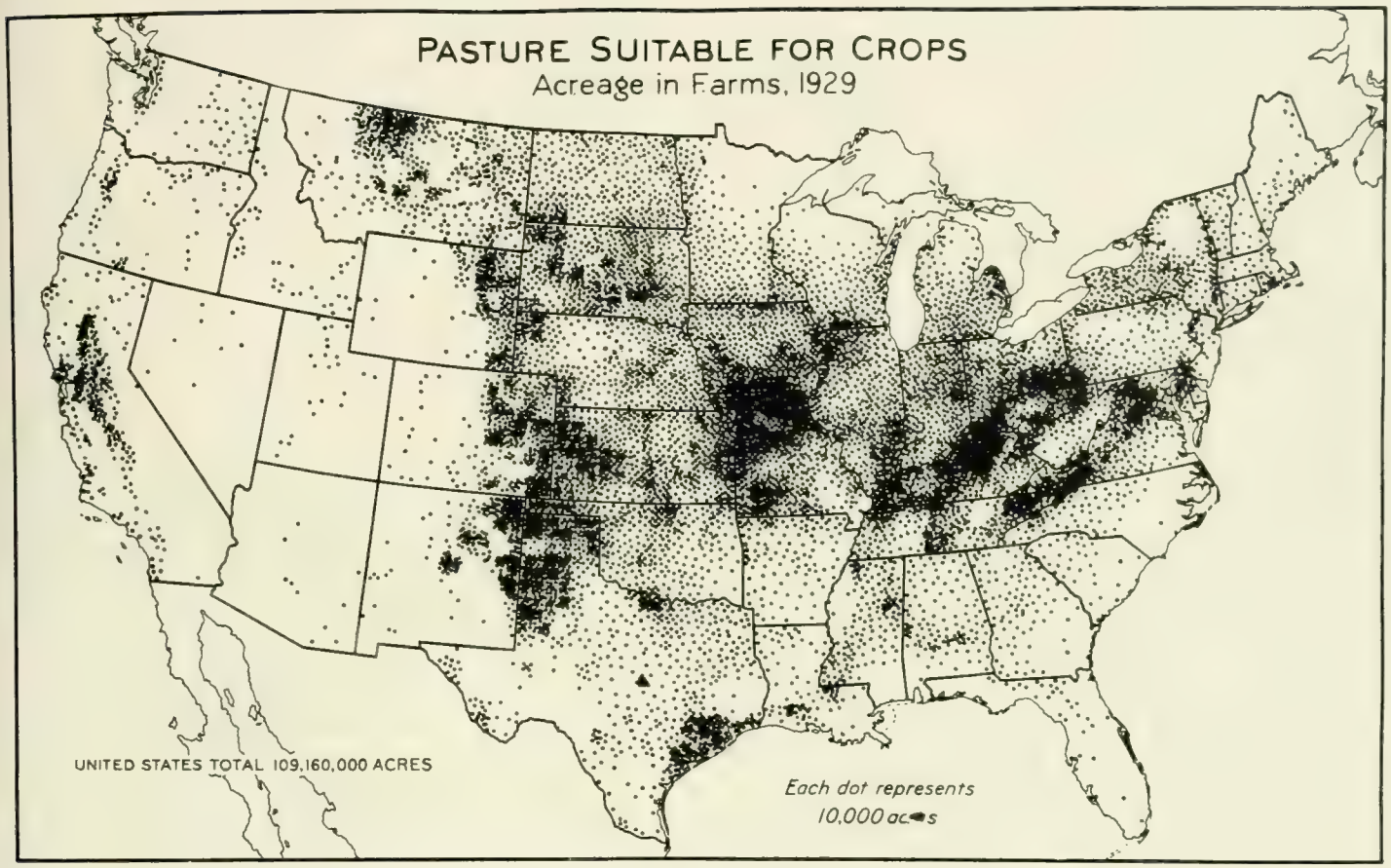

FIGURE 19.—Six sections where plowable pasture is very important can be seen on the map: (1) The Bluegrass Basin of Kentucky, (2) the Valley of Virginia, and (3) the lower Shenandoah Valley, all areas of limestone soils often shallow (Hagerstown series), (4) the upper Ohio Valley, having soils partially derived from limestone, (5) the flat uplands in northern Missouri and southern Iowa, and (6) the southern Great Plains ("high plains") extending from western Nebraska to the Edwards Plateau in Texas, which, though much larger, are much lower in carrying capacity per acre because they are semiarid. This high plains territory was rapidly passing from grazing to crop farming during the decade following the war, but the recent seasons of drought doubtless have made farmers less sanguine that this dry land is suitable for crops, particularly in New Mexico, southeastern Colorado, and in portions of Wyoming and Montana.

thirds of the pasture land, including range[7] (measured in area), is not in farms. For 1909, 1924, and 1929 the census provides figures of pasture land in farms, but for other years and for pasture and grazing land not in farms it is necessary to make estimates of area. Additional uncertainty is introduced into studies of pasture productivity by the fact that no census figures, or other extensive data, are available as to acre yields, as with crops, and that estimates of carrying capacity are subject to a much greater element of personal opinion than is the case with crop yields. In considering the following tables these difficulties in estimating the extent and productivity of pasture land should be kept in mind.

Because of the inadequacy of the data it is even more difficult to measure the trends in the area and productivity of pasture and range land. The plowing up of the native sod as crop production expanded onto the prairies and later onto the plains reduced the area of these grazing lands about as follows:

[7] Range is considered in this report as native forage land suitable for livestock grazing.

	Acres [8]
1880–89	43, 000, 000
1890–99	61, 000, 000
1900–09	17, 000, 000
1910–19	54, 000, 000
1920–29	24, 000, 000

But a much larger area of natural grazing land was not plowed up as agricultural settlement extended westward; consequently, the acreage of range pasture in farms was increasing. Moreover, some arable land in the East and South, particularly in hilly regions or on poor soils, has been reverting to pasture, as fertility diminished or as it was found unprofitable to compete with products from the West. But the increase in pasture acreage has not been as large as the decrease in crop acreage, because some of the pasture has reverted, in turn, to forest or brush. The census figures of pasture in farms for the continental United States are as follows:

[8] These figures are the increase of crop acreage in the nonforested counties of the United States. Presumably this land was used for grazing prior to its cultivation.

Pasture in farms	1909	1924	1929
	Acres	*Acres*	*Acres*
Plowable pasture in farms ("improved land in pasture" in 1909)	84, 226, 000	113, 567, 000	109, 160, 000
Woodland pasture in farms	98, 445, 000	76, 704, 000	85, 321, 000
Nonplowable pasture in farms ("all other land used for pasture")	108, 768, 000	217, 687, 000	269, 673, 000

It will be noted that the great increase is in the nonplowable or "other" pasture, which is located mostly in the Great Plains region and locally in the States to the west, with minor centers in the upper Ohio Valley and in the hill lands of New York and New England. (See fig. 18.) Much former open-range land has been included within farm boundaries in the Great Plains region and westward during the last quarter century. Plowable pasture is also extensive in the Great Plains region, particularly in the more level central and southern portions, but it is wide-spread in most of the central and eastern States as well. (See fig. 19.)

It is very probable that the productivity of pasture land in the United States as a whole is diminishing. In the sections of the East where agriculture is receding, many million acres of pasture are becoming weedy, while other vast acreages are growing up to brush or trees. In some cases this partial abandonment is owing to the ravages of erosion, in other cases to depletion of soil fertility by grazing, without restoration of the minerals removed. Where agriculture is not receding and there has been no abandonment of the pastures to the restorative processes of nature, the depletion of soil fertility in many cases may be almost as great. The use of fertilizers on pastures is almost unknown in the United States, and seldom is manure applied other than the droppings of the animals. Comparing the estimates in table 3 with those resulting from a similar study of productivity of pasture for the year 1919 (see Agricultural *Yearbook*, 1923, p. 369), it appears that there has been an average decline per acre of 10 percent or more.

The big expansion in livestock production on western range lands occurred following 1870. By 1885 many ranges undoubtedly were overstocked. Continued heavy stocking combined with drought caused severe loss of productivity before 1900. Livestock were pushed farther and farther back into unwatered or otherwise naturally protected range areas. The regulation of grazing on national forests has aided restoration of lands included within them but, in the main, western range lands have continued to decline in productivity since 1900.

Between 1900 and 1930 the number of domestic livestock in the 11 western States, with some annual variation, remained at approximately 17 to 18 million animal units.[9] In 1900 there were millions of wethers

TABLE 3.—*Animal units carried by pasture in the United States*

[Estimated number in 1929

	Acres (1,000)	Acres per animal unit and length of season	Number of animal units carried (1,000)	
			Season	Year long equivalent
Humid and subhumid pasture:				
Plowable in farms	76,000	3 for 6 months	25,333	12,666
Nonplowable in farms:				
East	80,000	7 for 6 months	11,429	5,714
West	20,000	12 for 9 months	1,667	1,250
Privately owned not in farms	26,000	15 for 9 months	1,733	1,300
National forest (alpine)	2,000	6 for 3 months	333	83
Indian reservations	2,000	10 for 9 months	200	150
Other publicly owned	2,000	15 for 9 months	133	100
Total	208,000			21,263
Semiarid and arid grazing land:				
Grassland and desert shrub:				
Plowable in farms	33,000	12 for 6 months	2,750	1,375
Nonplowable in farms	170,000	25 for 9 months	6,800	5,100
Privately owned, not in farms	100,000	30 for 9 months	3,333	2,500
National forests	20,000	20 for 6 months	1,000	500
Indian reservations	26,000	40 for 9 months	650	488
Other publicly owned	17,000	50 for 8 months	340	227
Public domain (excluding next item and woodland)	121,000	75 for 6 months	1,613	806
Mohave-Gila Desert	13,000	75 for 2 months	173	29
Total	500,000			11,025
Pinon-juniper, chaparral, and other noncommercial forest (including 21,000,000 acres in national forests, 19,000,000 acres in public domain, and 7,000,000 acres in Indian reservations)	88,000	70 for 9 months	1,257	943
Forest and cut-over land:				
In farms (commercial)	62,000	25 for 6 months	2,480	1,240
Privately owned, not in farms	128,000	30 for 6 months	4,267	2,134
National forests	46,000	30 for 5½ months	1,533	703
Indian reservations	5,000	35 for 6 months	143	72
Other publicly owned	5,000	30 for 6 months	167	84
Total	246,000			4,233
Temporary crop-land pasture:				
Hay aftermath	22,000	3 for 1½ months	7,333	917
Stubble fields	40,000	5 for 2 months	8,000	1,333
Winter grain fields	8,000	5 for 3 months	1,600	400
Total	70,000			2,650
Total grassland pasture	708,000			32,288
Total grassland, forest, and woodland pasture	1,042,000			37,464
Temporary crop-land pasture	70,000			2,650
Total pasture	1,112,000			40,114

[9] An animal unit is considered here to be equivalent to 1 cow, or 1 horse, or 5 sheep or goats.

grazing the range, and many steers were kept until they were 2 or 3 years old. In 1930 a much higher percentage of the animal population was made up of breeding cows and ewes, calves and lambs being shipped from range lands to feed lots for finishing.

In the face of continued depletion of productivity of range lands from 1900 to 1930 it may seem strange that numbers of livestock have not declined. This is undoubtedly due to the increase in irrigated areas. Total land under irrigation in 19 western States increased from 4 million acres in 1890 and 8 million in 1900 to between 19 and 20 million in 1920 and 1930. The greater use of irrigated pastures and supplemental feeding has been a big factor in preventing drastic reductions in the number of livestock during the last 30 to 40 years.

The range area has increased in the last 15 years by about 15 million acres of formerly cultivated dry-farm land, which is now of very low forage productivity, owing to the slowness with which the natural sod became reestablished.

In the range area, both within and without farms, except in the national forests, the natural grassland continues to be overgrazed. Erosion is serious, losses of the surface soil by wind now being added to the losses by running water.

Arable Land and Pasture Relationships: The proportions of the total feed units utilized by livestock in the United States secured from feed grain, hay, silage, and pasture have been estimated as indicated in table 4.

The several classes of livestock utilize the different feed grains in various proportions. Pasture varies greatly in quality and carrying capacity from one section of the country to another, and although for the country as a whole one grazing unit [10] is equivalent to about 11 acres, it has been estimated that it takes 30 acres in the range livestock type of farming area and only 2 to 3 acres in the Corn Belt to equal one grazing unit.[11] Owing to the fact that different classes of livestock are distributed in varying proportions in different sections of the United States, there is a wide difference between the acres actually utilized by the different classes of livestock and any "average" pasture acre which might be calculated for comparative purposes.

It is evident that the several classes of livestock vary considerably with respect not only to their ability to convert feed units into livestock food products, but also to the type of land the produce of which they can utilize.

As indicated heretofore, the quantities of pork and beef consumed in the American diet are not widely different. As regards acreage required for production, however, pork depends almost exclusively upon the several feed grains, while beef represents a greater contribution from pasture and hay than from the feed grains. It is evident, therefore, that a substitution of pork for beef would require a greater acreage in feed grains, and that conversely, the substitution of beef for pork would permit an increase in pasture and a decrease in acreage of feed grains. Similarly, a change from pork to dairy products would permit a shift in the direction of less feed grains and more hay and pasture, though not so far as beef cattle.

Even though there have been changes in the proportion of different meats in the American diet, and although further changes are entirely possible, the most reasonable conjecture as to the future seems to be that such shifts will be slight. On this assumption it is estimated that in addition to the feed-grain requirements already indicated there will be required by 1960 perhaps 953 million acres of average pasture (or its equivalent), or about 102 million acres more than in 1929. However, the quality of different types of pasture varies so greatly, and the possibilities of improving carrying capacity of pasture are so great, that much of the required additional pasture equivalent may be secured by more effective and efficient utilization of existing pasture.

TABLE 4.—*Utilization of feed units by type of livestock and type of feed* [1]

Type of livestock	Percent of total feed units				
	Feed grains	Hay	Silage	Pasture	Total
Dairy cattle	5	6	3	14	28
Beef cattle	3	5	(2)	16	24
Hogs	16			1	17
Sheep and goats	(2)	(2)	(2)	4	4
Poultry	4			(2)	4
Horses and mules	12	5		6	23
Total [3]	40	16	3	41	100

[1] The feed-unit equivalents are as follows:

	Feed units
1 pound of corn	1.00
1 pound of oats	.85
1 pound of barley	1.08
1 pound of grain sorghum	1.00
1 pound of hay	.40
1 pound of silage	.17
1 grazing unit	2,250.00
1 acre pasture (average quality)	203.50

Concentrate by-products are not included in these calculations.

[2] Less than 1.

[3] The total feed value of feed consumed by livestock distributed between the various types of food.

Summary of Acreage Requirements for Agricultural Production

It is fundamental to the formulation of an adequate land policy that plans be sufficiently elastic to expand or contract acreage as changing circumstances warrant, and to accomplish these results without leading to the various forms of distress that have resulted from our lack of policy in the past.

[10] A grazing unit is the feed value of the grazing secured in a season by the average dairy cow. It is equivalent to 2,250 feed units

[11] Excluding the truck-farming area, these averages are the extremes for the averages over each of the 12 major types of farming classifications as given by the 1930 census.

The estimates in table 5 are not presented as forecasts in the usual meaning of the term, but rather as estimates of the probable result which may be expected if the assumptions upon which they are predicated are realized with the passage of years. The assumptions underlying the table cannot be explained in detail at this point. Briefly, they accept the conclusions presented elsewhere in the report respecting population prospects, exports and imports, and prospective yields.

In regard to exports, since the prospects depend on a number of highly uncertain factors, both maximum and minimum figures have been shown for each item. The minimum figures have been inserted mainly in the interests of caution, and represent what is to be expected if the underlying conditions continue as at present. The maximum figures are to be regarded as definitely within the range of possibility so far as our present knowledge indicates.

The estimates for a given date—as, for instance, 1940—do not signify that in that particular year the acreage would be precisely as estimated, for the yearly fluctuations are considerable. They merely imply that an average of these fluctuations for a number of years centering on the year mentioned would approximate the estimate given.

Although, as indicated in table 5, it probably will be necessary by 1960 to add considerably to our crop acreage, there is no immediate necessity for such action. In fact, for the next few years ahead or until there is a decided improvement in both domestic and foreign demand for our agricultural products, we shall need to shrink our present crop area. Probably the most feasible way to do this is to extensify our farming by substituting pasture or hay, or other erosion-preventing and soil-improving crops for the more intensive crops now produced in excess. Such a policy not only will reduce expenses of production but also will conserve our soil resources and minimize the serious problem of erosion. Likewise, it provides for flexibility in operation, permitting either expansion or contraction as future conditions warrant.

Land Available for Cultivation

Now that we have reviewed the general outlook for land requirements in agriculture it is well to consider briefly the land available to meet these requirements

Uses of Land for Farming: The following table shows the size of our present farm plant and the distribution of the land among various uses.

TABLE 6.—*Present use of land for farming*

Present use	Including stock ranches	Excluding stock ranches
	Acres	*Acres*
Land in farms	986, 772, 000	779, 998, 000
Crop land, total	413, 236, 000	
Crop land harvested	359, 242, 000	350, 612, 000
Crop failure	12, 707, 000	
Idle or fallow	41, 287, 000	
Pasture land, total	464, 155, 000	
Plowable pasture	109, 160, 000	92, 078, 000
Woodland pasture	85, 322, 000	
Other pasture	269, 673, 000	108, 400, 000
Woodland not pastured	64, 624, 000	
All other land in farms	44, 757, 000	

As already indicated, a good deal of the present arable area is very inferior, and some of it so inferior that its continued cultivation is not desirable.

Physical Classification of Productivity of the Land: A preliminary physical classification of the estimated acreage of land in the United States falling within each of five grades of productivity, based on its natural productivity for crops, shows the following distribution:[12]

[12] This estimate was prepared under the direction of Dr. Curtis F. Marbut, Bureau of Chemistry and Soils, United States Department of Agriculture.

TABLE 5.—*Acreage requirements for domestic consumption and exports—United States farm products*

[Millions of acres]

Year	Wheat			Corn			Oats			Barley			Cotton			Tobacco			Hay	Other crops	Total crops harvested
	Domestic consumption	Exports	Total	Domestic consumption	Exports	Total	Domestic consumption	Exports	Total	Domestic consumption	Exports	Total	Domestic consumption	Exports	Total	Domestic consumption	Exports	Total	Domestic consumption	Total	
1940	46.1	5.8–7.8	51.9–53.9	98.8	2–3	100.8–101.8	37.3	0.3	37.6	9.7	0.7	10.4	18.0	22.0–24.6	40.0–42.6	1.1	0.8	1.9	67.9	37.7	348.2–353.8
1945	47.4	5.8–9.7	53.2–57.1	101.6	2–3	103.6–104.6	38.3	.3	38.6	9.9	.7	10.6	18.5	22.0–25.8	40.5–44.3	1.2	.8	2.0	69.8	40.6	358.9–367.6
1950	48.5	5.8–9.7	54.3–58.2	103.8	2–3	105.8–106.8	39.2	.3	39.5	10.1	.7	10.8	18.9	22.0–27.1	40.9–46.0	1.2	.8	2.0	71.3	42.1	366.7–376.7
1955	49.2	5.8–9.7	55.0–58.9	105.3	2–3	107.3–108.3	39.7	.3	40.0	10.3	.7	11.0	19.2	22.0–28.3	41.2–47.5	1.2	.8	2.0	72.3	42.6	371.4–382.6
1960	49.6	5.8–9.7	55.4–59.3	106.1	2–3	108.1–109.1	40.0	.3	40.3	10.4	.7	11.1	19.3	22.0–29.5	41.3–48.8	1.3	.8	2.1	72.9	42.6	373.8–386.2

The basic assumptions underlying these estimates are that:

(1) Per-capita consumption of food crops will continue at about predepression levels;

(2) Increased efficiency in the production of livestock products from feed will be reflected to a substantial degree in greater per capita consumption, thus resulting in little net change in the per capita acreage required to produce livestock products for human food;

(3) The number of horses and mules for power will be about the same in 1940 as in 1934, and after 1940 the number will increase about in proportion to total acreage; and

(4) Exports will be approximately as given in the export section of the text. In the case of several crops, both a high and low estimate are given, separated by a dash. In these instances, the total acreages are also given as high and low estimates.

Should exports fall below these estimates, or drastic changes occur in the proportion of the various livestock products consumed, or mechanization develop more or less rapidly than here assumed, corresponding changes would occur in the acreage requirements. The assumptions given above, however, appear to be the most tenable for the purpose of forming a reasonable estimate of land requirements for the next quarter of a century, it always being understood that any land program should be sufficiently flexible to allow for such significant changes as develop.

	Acres
Grade 1	101, 038, 000
Grade 2	210, 935, 000
Grade 3	345, 872, 000
Grade 4	362, 559, 000
Grade 5 (essentially nonarable)	881, 735, 000

It should be noted that the above classification is applied to the entire land surface of the United States, whether the land is in farms or not in farms. It takes into consideration the principal physical conditions influencing productivity, such as soil type, topography, rainfall, and temperature.

Grade 1 may be briefly described as excellent land for the staple crops climatically adapted to the region in which it lies; grade 2 as good; grade 3 as fair; grade 4 as poor; and grade 5 as essentially incapable of tillage.

Since an accurate inventory of the lands of the United States according to their physical productivity is dependent upon the completion of the soil survey (the soil survey has covered less than half the total area of the country), as well as upon more complete data on topography and climatic conditions, the above estimate is necessarily of the most tentative character. Lack of adequate soil surveys for a number of States makes it impossible to complete the estimate for the entire country on the same basis and with the same degree of reliability as for the surveyed areas, but in this report these unsurveyed areas have been included, the estimates being based on the best data available. They are necessarily inaccurate in detail.

Naturally poorly drained lands were graded according to their productivity under their present condition of drainage, whether they are artificially drained or not. Irrigated lands were graded according to their original nonirrigated condition, because of the lack of any adequate basis for making a productivity class of present irrigated land.

The distribution of the acreage in these various grades by States is shown in the following table:

TABLE 7.—*Preliminary inventory of land productivity classes of the United States*

State	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
	Acres	*Acres*	*Acres*	*Acres*	*Acres*
Alabama		3, 002, 499	9, 528, 183	10, 730, 251	9, 490, 887
Arizona				949, 313	71, 916, 087
Arkansas	1, 452, 484	7, 952, 405	9, 231, 149	8, 299, 905	6, 707, 425
California	46, 976	478, 297	3, 364, 517	13, 380, 327	82, 347, 163
Colorado		285, 670	7, 041, 281	13, 743, 839	45, 270, 330
Connecticut	48, 452	338, 620	902, 062	962, 120	850, 826
Delaware		222, 080	350, 784	417, 216	273, 280
Florida	71, 161	933, 187	3, 928, 412	12, 892, 726	17, 077, 968
Georgia		1, 851, 537	15, 614, 067	9, 750, 361	10, 368, 603
Idaho		87, 288	949, 208	3, 728, 908	48, 581, 156
Illinois	14, 777, 030	6, 847, 145	6, 223, 171	6, 621, 568	960, 998
Indiana	5, 262, 498	6, 438, 377	7, 743, 581	2, 436, 801	1, 153, 367
Iowa	25, 983, 110	6, 906, 158	1, 392, 680	1, 007, 416	344, 556
Kansas	3, 765, 287	15, 172, 236	15, 964, 703	11, 207, 323	6, 094, 867
Kentucky	863, 916	5, 020, 424	8, 956, 319	7, 905, 826	2, 877, 195
Louisiana	1, 289, 430	2, 972, 742	7, 346, 623	12, 442, 991	5, 024, 118
Maine		1, 615, 033	3, 788, 506	5, 791, 456	7, 977, 805
Maryland	143, 732	1, 874, 527	1, 445, 544	1, 859, 409	972, 532
Massachusetts	11, 906	759, 807	1, 274, 906	1, 644, 453	1, 367, 488
Michigan	2, 251, 155	8, 961, 198	5, 386, 738	7, 228, 991	13, 223, 254
Minnesota	12, 022, 243	12, 138, 815	7, 511, 325	6, 898, 992	13, 144, 839
Mississippi	844, 230	5, 336, 459	8, 614, 697	10, 928, 882	4, 090, 950
Missouri	8, 674, 763	13, 833, 050	12, 303, 627	4, 258, 868	4, 914, 778
Montana			7, 366, 681	30, 438, 292	55, 565, 267
Nebraska	8, 120, 907	9, 690, 068	9, 639, 648	10, 908, 321	10, 757, 984
Nevada				76, 900	70, 208, 480
New Hampshire	2, 330	237, 212	370, 426	1, 671, 601	3, 478, 271
New Jersey	6, 272	943, 268	963, 896	1, 379, 108	1, 471, 016
New Mexico			914, 304	6, 060, 758	71, 426, 858
New York	94, 037	6, 863, 934	9, 248, 628	9, 172, 273	4, 927, 960
North Carolina		1, 166, 506	11, 360, 152	9, 381, 729	9, 285, 453
North Dakota		7, 365, 682	17, 715, 865	14, 151, 534	5, 679, 955
Ohio	4, 214, 074	6, 234, 205	10, 439, 723	3, 809, 973	1, 374, 625
Oklahoma	1, 700, 604	12, 795, 160	15, 268, 765	7, 825, 536	6, 856, 079
Oregon	342, 536	2, 059, 425	4, 694, 454	5, 464, 700	48, 567, 845
Pennsylvania	177, 151	6, 268, 104	9, 496, 900	5, 908, 804	6, 909, 469
Rhode Island		5, 463	228, 082	71, 019	378, 316
South Carolina		296, 359	7, 069, 959	7, 127, 990	5, 022, 890
South Dakota	3, 052, 320	8, 775, 365	8, 960, 392	15, 552, 419	12, 821, 104
Tennessee	902, 258	4, 769, 847	9, 305, 437	8, 239, 726	3, 412, 108
Texas	1, 591, 147	19, 460, 508	54, 974, 391	35, 950, 166	56, 098, 156
Utah				1, 233, 459	51, 364, 301
Vermont	33, 217	900, 588	1, 268, 238	2, 185, 398	1, 451, 919
Virginia		3, 653, 134	9, 279, 761	7, 312, 200	5, 399, 769
Washington	83, 529	542, 138	6, 537, 431	6, 760, 172	28, 836, 291
West Virginia	388, 551	1, 350, 227	2, 986, 643	7, 647, 077	2, 827, 790
Wisconsin	2, 820, 276	14, 529, 981	8, 396, 995	4, 564, 307	5, 271, 021
Wyoming			522, 936	4, 577, 769	57, 314, 015
Total	101, 037, 573	210, 934, 728	345, 871, 800	362, 559, 173	881, 735, 414
Percentages	5.3	11.1	18.1	19.1	46.4

Lands Proposed for Retirement from Agriculture: In order to determine how much of the land in farms and in cultivation should be retired from cultivation because of its economic inferiority, the land consultants in each of the 48 States were directed to consult the various sources of agricultural information and to map the townships which the consensus of well-informed opinion adjudged economically and socially unsuited for continued cultivation. A tabulation of the area within these townships shows a total of 51,575,000 acres in crops. Of this total, 20,163,000 acres are on the farms which it is proposed to retire.

If the area adjudged unsuitable for continued cultivation be subtracted from the 413 million acres of crop land in the United States (including crop failure and crop land lying idle or fallow) in 1929, the remaining area falls very largely in grades 1, 2, and 3 of the above classification, although a relatively small part is found in grade 4, in situations where some economic advantage such as favorable location with respect to markets, or very low production cost, compensates for the low productivity of the land.

It seems desirable to encourage the withdrawal from cultivation of the poor lands just as rapidly as alternative opportunities can be found for the dependent population. The total area of land in farms containing this crop land is about 75 million acres. In the forested regions, retirement of these farms will involve retirement of some pasture, which may be more or less offset by an increase in grazing land attendant upon the retirement of crop land in the nonforested regions.

The net effect on pasture acreage of retiring agriculture from the poorer lands will be an increase of 1,600,000 acres of pasture. The remaining land on farms to be retired is mainly forest, and its status as forest presumably will not be changed through farm retirement.

A small amount of farm land which is physically and economically suitable for agriculture is of high utility for some public use, notably recreation, and may sooner or later be devoted to such a purpose.

To offset the 20,163,000 acres of crop land that would be eliminated through withdrawal of farming in certain areas plus the 5,200,000 acres that would be retired under a proposed program of increasing the size of farm units in certain areas to include more pasture, a total of 25,363,000 acres of crop land of equivalent productivity, or about 17 million acres of average productivity, will be needed. In addition, about 30 million acres more crop land than at present will be needed to meet the prospective requirements of 1960. Thus, a total of 47 million acres of additional crop land would have to be found by 1960, provided the average productivity remained about as at present.[13] Of this, about 5 million acres would presumably be needed to allow for fallow and crop failure.

Sources of Additional Crop Land: In order to meet the additional prospective requirements and to offset the areas retired from cultivation, several possible sources of additional production of agricultural crops may be considered. One possible source, already discussed, is through more intensive use of the better land now in farms. The arable area might be increased also, if necessary, through the conversion of plowable pasture to crops. Even allowing for the low carrying capacity of much of our pasture land, the ratio of pasture to land in crops is higher than prevails in the more densely peopled countries of western Europe. A high ratio of pasture land to crop area is an expression of relative abundance of land resources in relation to requirement. Finally, a considerable area of land not now in farms is sufficiently productive to warrant cultivation as soon as increased demand justifies the cost of bringing it into production through clearing, draining, irrigation, or other improvements.

There is probably in excess of 100 million acres of land not now in farms which, when drained, irrigated, or cleared, would be more productive for crops than the crop land from which it is now proposed to encourage retirement. Of this total, a considerable area is fairly well adapted to cultivation without drainage or irrigation, although for most of it clearing would be requisite.

Cut-over Land: Areas not in farms and suitable for farming without drainage or irrigation consist largely of forest or cut-over land requiring clearing. It has been estimated that there are about 170 million acres of such land, physically capable of producing crops without drainage but requiring clearing, excluding land of rough surface and loose sandy soils.[14]

In addition there are approximately 50 million acres of woodland in farms which are topographically suitable for farming without drainage, although the quality of the land is generally low. A large part of this land is probably used for pasture at present. Much of this land, however, is distinctly inferior to the desirable agricultural land now in crops, and a considerable part is certainly no better than some of the land from which it is proposed to retire agriculture. It is estimated that the greater part of this land, probably three-fourths or more, is land having light-textured soils suitable for vegetables, fruits, and other intensively cultivated crops such as cotton or tobacco, but less well adapted to grains and grasses. The additional requirements for these intensive crops are not likely to be great enough to make it necessary to utilize a very large proportion of these lighter soils. On the whole, this class of land is less productive than the better class of land requiring drainage, particularly less than the alluvial lands. It is doubtful if more than 40 million acres would be distinctly more productive when improved than some of the land from which it is proposed to encourage agricultural retirement.

The amount, species, and size of forest growth on these lands are factors which affect land clearing costs. The size of the growth may vary from seedlings on new cut-over areas to large second growth or mature timber on the older areas. Though the original stumps may decay with age, the second growth is continuously increasing in size and becoming more difficult to remove. The amount of growth and the species may also vary somewhat. Therefore estimates of land clearing costs must necessarily be rough because of lack of information concerning the conditions which determine the cost of requisite labor and materials.

In addition to the physical conditions, the method used may appreciably affect the cash cost of the several land clearing operations. Brushing costs may be reduced by pasturing, particularly goats and sheep. The quality of this wild pasture is gradually improved as the smaller brush is killed by trampling or browsing. Brushing costs can also be materially reduced if the area is burned over a year or two before the actual removal of the brush; this is particularly true of aspen. It has been found in the Lakes States that clover catches well on burned-over land and that wild pasture can be improved by seeding. Where brushing has been done

[13] In the preparation of table 2 and fig. 10, in which only acreage was considered, allowance could not be made for the higher productivity of the land to be brought into use for crops as compared with that proposed for retirement. Hence the figure employed for necessary additional arable acreage was 55,000,000.

[14] L. C. Gray, O. E. Baker, F. J. Marschner, and B. O. Weitz, Bureau of Agricultural Economics, and W. R. Chapline, Ward Shepard, and Raphael Zon, Forest Service, "The Utilization of Our Lands for Crops, Pasture, and Forests", Department of Agriculture, *Yearbook*, 1923, p. 415.

NATIONAL RESOURCES BOARD
LAND USE SECTION
IRRIGATION MAP
OF THE
UNITED STATES
Irrigated Areas are revised from Irrigation Map 1930 Census of the Department of Commerce Bureau of Census.
Irrigated areas shown in red
Scale 1:13,875,000
100 0 100 200 300 400 500 600 Miles

by cutting, further brush growth can be suppressed by pasturing until the stumps have been removed and the land plowed.

Stump removal costs can be reduced by waiting until some decay has taken place, in case of species which decay rapidly, such as hardwoods and some pines. Such species as white and long-leaf pine have an extremely slow rate of decay. Removal and disposal of green stumps is costly, laborious, and slow, and is done only under exceptional conditions.

TABLE 8.—*Costs of clearing cut-over land under average conditions*

	Estimated clearing cost per acre		*Estimated clearing cost per acre*
Alabama	$10	Missouri	$50
Arkansas	50	Montana	40
California	200	New Jersey	15
Connecticut	40	North Carolina	20
Delaware	40	Oklahoma	30
Florida	10	Oregon	200
Georgia	10	Rhode Island	40
Idaho	50	South Carolina	20
Kentucky	40	Tennessee	30
Louisiana	20	Texas	20
Maryland	35	Virginia	30
Michigan	50	Washington	200
Minnesota	50	West Virginia	40
Mississippi	10	Wisconsin	50

[Estimates by Bureau of Agricultural Engineering. Estimated cost not given for Maine, Massachusetts, New York, New Hampshire, Pennsylvania, and Vermont]

In the southern pine cut-over sections the occurrence of frequent fires has almost completely consumed the forest litter and tree tops left as a result of logging operations, as well as suppressed much of the brush growth. Brush removal costs in these sections are practically negligible. Because of the resinous condition of many of the pine stumps they may be burned with little cash outlay. In some sections of the South wood distillation plants offer a market for long-leaf pine stumps and down wood, and under favorable conditions the price paid may be somewhat more than the removal and haulage costs.

In the timber sections of the West stump removal and disposal costs are high because of the size of the stumps. The usual procedure is to blast with dynamite or to pull with machinery. Under favorable conditions stumps in this section may be burned at a considerable saving in cash but with a considerable expenditure of time.

In table 8 are tabulated clearing costs per acre of cut-over lands, by States. The cost estimates represent average conditions.

Irrigable Land: Representatives of thu e Bureaof Agricultural Engineering have made new first-hand estimates of the potential additional irrigable area of the United States. This estimate was made by visiting the various arid States and estimating for the various projects and additions to projects that have been proposed from time to time. Since the cost factor is an important consideration in economic potentiality, an attempt was made to classify the various areas in broad cost-groups. The result is shown in table 9. It appears that there is a total of 26,376,000 acres that could be added if cost is disregarded, but only 7,114,000 acres at a cost of less than $100 per acre, and 10,330,000 acres at a cost of less than $200. The area that could

TABLE 9.—*Present irrigation development as indicated by the irrigation census of 1930 (marked*), and the ultimate possibilities of irrigation reclamation, for 17 western States*

Summary by States	Present development		Additional irrigable area (potential)	Ultimate irrigable area	Distribution of additional irrigable area according to estimated costs of reclamation, per acre (does not include any charge for land preparation)				
	Area irrigated 1929*	Area enterprises were capable of supplying with water 1930*			Less than $50 per acre	Between $50 and $100 per acre	Between $100 and $200 per acre	More than $200 per acre	Indeterminate at this time
	Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
Arizona	575,590	824,152	754,600	1,578,800	19,700	33,000	39,100	594,600	[1] 68,200
California	4,746,632	6,815,250	9,857,750	16,673,000	1,031,079	.....	.....	.....	[2] 8,826,671
Colorado	3,393,619	4,078,712	957,600	5,036,300	.....	12,500	246,300	.....	698,800
Idaho	2,181,250	2,617,021	1,138,500	3,755,500	20,000	407,500	525,000	71,700	114,300
Kansas	71,290	83,583	1,250,000	1,333,000	50,000	.....	.....	.....	1,200,000
Montana	1,594,912	2,276,000	1,589,600	3,865,600	116,000	148,900	94,000	413,700	[3] 817,000
Nebraska	532,617	703,641	1,069,600	1,773,200	51,500	125,300	63,400	16,200	813,200
Nevada	486,648	736,249	326,700	1,065,600	38,400	161,300	.....	.....	127,000
New Mexico	527,033	656,669	434,200	1,090,800	86,100	172,500	12,000	65,000	98,600
North Dakota	9,392	24,006	288,000	312,000	86,000	10,000	31,300	.....	160,700
Oklahoma	1,573	7,331	120,000	127,400	80,000	.....	.....	.....	40,000
Oregon	898,713	1,158,210	2,354,600	3,512,900	1,481,100	509,500	222,000	.....	142,000
South Dakota	67,107	109,550	112,800	222,400	15,000	.....	60,000	37,800	.....
Texas	798,917	1,177,415	1,070,000	2,247,400	139,000	760,000	.....	.....	171,000
Utah	1,324,125	1,542,475	622,400	2,164,900	56,000	26,000	186,100	88,500	265,800
Washington	499,283	631,511	2,024,000	2,655,500	46,000	35,400	1,345,100	26,000	571,500
Wyoming	1,236,155	1,655,008	2,405,700	4,060,600	508,100	888,300	392,000	42,800	574,500
Total	18,944,856	25,096,783	26,376,050	51,474,900	3,823,980	3,290,200	3,216,300	1,356,300	14 689,270

[1] Large area under high line survey excluded as infeasible because another part is included in another plan.

[2] Coordinated State plan for old and new lands; municipal and industrial purposes, does not segregate charges. Much of this area will cost around $100 per acre for new lands, including storage, conveyance canals, and distribution system.

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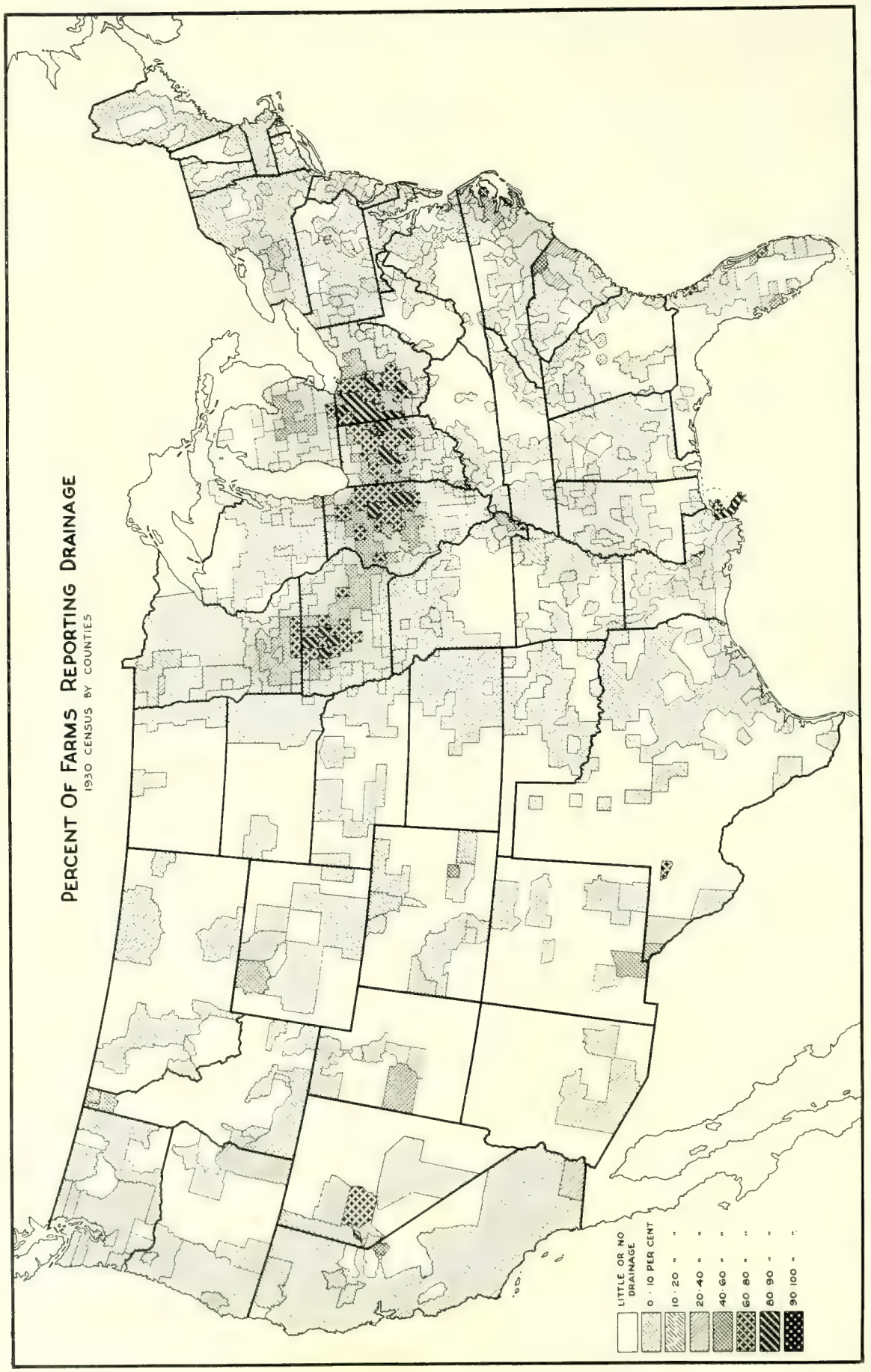
PERCENT OF FARMS REPORTING DRAINAGE
1930 CENSUS BY COUNTIES
LITTLE OR NO DRAINAGE
0 - 10 PER CENT
10 - 20 " "
20 - 40 " "
40 - 60 " "
60 - 80 " "
80 - 90 " "
90 - 100 " "

FIGURE 20.—The 1930 Census of Agriculture determined the number of farms in each county provided with artificial drainage works, chiefly ditches, tiles or levees. Farms having only temporary work, such as "bedding," were not included. Farms provided with drainage may or may not be located within an organized drainage district. Usually the drainage is the result of work done by the farm owner, and may be independent of, or supplemental to, the works of an organized drainage enterprise. Farms with part or all of their areas dependent on artificial drainage were included in determining the percent of farms in each county reporting drainage, as shown in above figure.

be added at an indeterminate cost is 14,689,000 acres. These figures compare with a present area in enterprises for which water is available of 25,097,000 acres, and with an area irrigated in 1929 of 18,945,000 acres. (See accompanying map.)

According to the 1930 census the total lands included in drainage enterprises comprised 84,408,093 acres, of which 63,514,081 acres may be classed as improved land. It is believed that, on account of overcapitalization or other causes, there are considerable areas within organized drainage districts which would afford opportunity for new settlers, provided suitable financial readjustments were made. Some of these enterprises were developed in the promotional period during the World War and were not economically feasible. Some districts are undergoing serious physical deterioration through financial inability to maintain the ditches and other drainage works. Some of the land also is poor soil which it does not pay to clear.

Drainable Land: Available information indicates there are about 91 million acres in the United States unfit for cultivated crops or improved pasture until it is supplied with adequate drainage. Such lands are found in every State, but the great bulk of these lands are found in the States from Maryland south along the Atlantic and Gulf coasts and in Arkansas, Missouri, Minnesota, Michigan, and Wisconsin. The potential agricultural value of these lands varies from very low to high fertility. In general, the better and more easily drained lands were developed first. Those that remain are either not of high fertility or suffer some disability that renders their successful utilization difficult—such as high cost of protecting from overflow, heavy clearing, storm tides, etc. (See fig. 21.)

Despite their disadvantages, these lands constitute one of the Nation's most available and economical reserves of agricultural lands when we have need to draw upon them. Probably one-third of these lands, whose fertility ranges from good to high, can be drained for an average price of not to exceed $30 an acre. To this cost must be added that of farm ditches, clearing, roads, fences, and buildings. From their topography these lands are little subject to erosion; neither is the percentage of waste land apt to be so high as in the uplands. Experience has shown also that drained lands are not so seriously affected by drought as upland. It seems probable that a careful study of existing and potential land use conditions would show that it would be in the interest of the individual concerned, and of the public, to transfer farmers from poor hill lands to fertile drained lands and to devote the land thus made vacant to new agricultural uses. However, it is desirable to avoid the mistakes of the past in undertaking projects not economically feasible. It is especially important to be sure that we are not destroying wildlife refuges of high utility and social value for those purposes in order to create new agricultural areas of doubtful value.

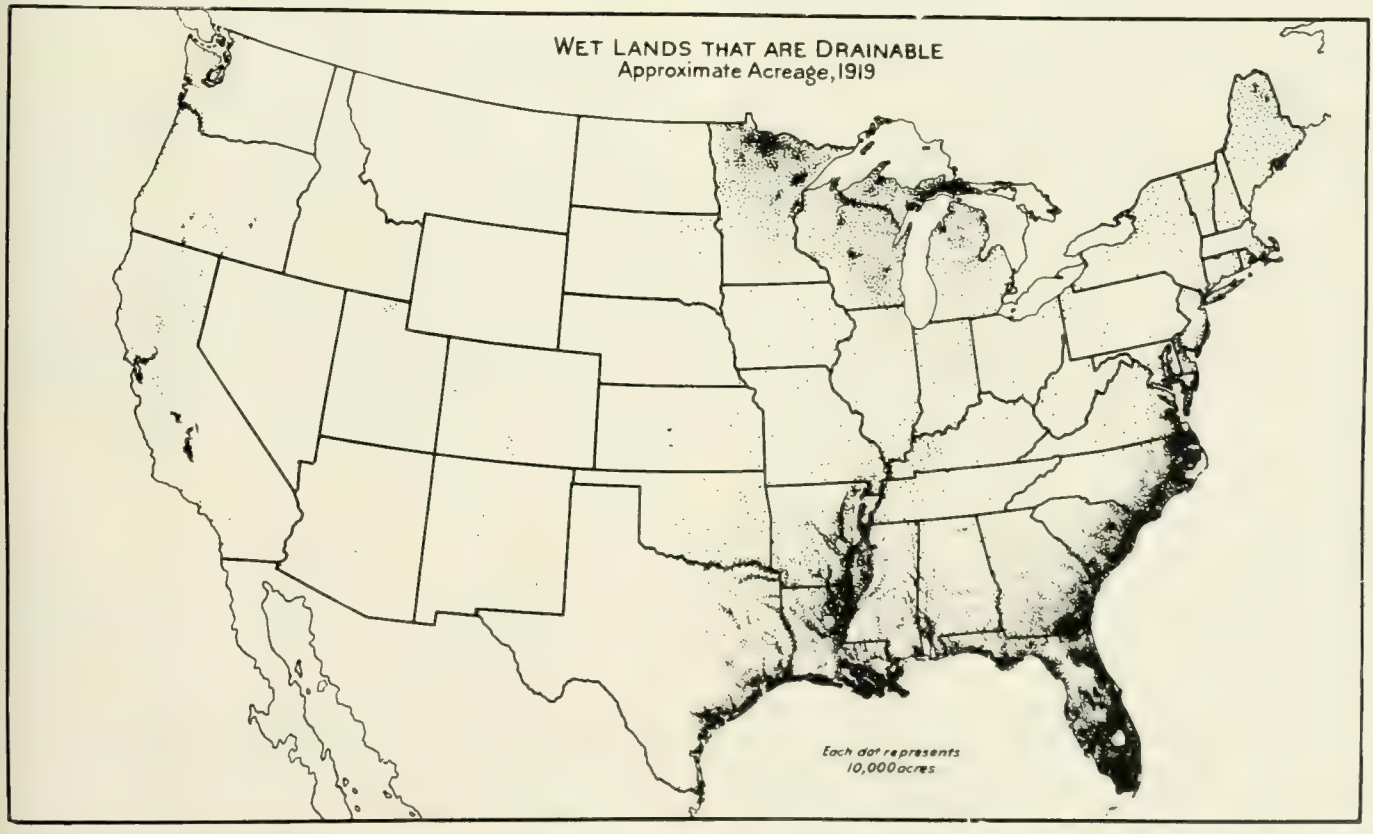

FIGURE 21.—An estimate was made of the total lands in need of community drainage in 1922. Since then some lands have been drained, reducing the area in need of drainage. On the other hand, some drainage enterprises have been abandoned since that time. The net changes in acreage in need of drainage since the estimate was made is believed comparatively small and now there are about 91,000,000 acres of land that could be drained and used for agricultural purposes, distributed approximately as shown by the above figure. Some of the lands in need of drainage are used for pasture or to secure partial crops in favorable years. At least three-fourths of these lands are swamps or timbered areas not used for agricultural purposes.

There are probably at least 1 million acres of land in the humid parts of the country requiring little or no clearing which, for various reasons, is not now farmed and which is desirable for agriculture, some of it suited to intensive or part-time farming. Much of this is former farm land adjacent to urban centers, held for speculation in anticipation of urban expansion greater than is likely, and now withheld from any productive use.

Prospective Modifications in the Geographic Distribution of Crop Acreage

Expansion in crop acreage during the past decades has not been uniform throughout the United States, and as total acreage expands in the future to meet consumption needs, continued lack of uniformity can be expected. The suitability of various regions for production, their situation with respect to markets, the availability of alternative crops, and the ease with which changing technique can be adopted may be expected to continue to exert a dominant influence on the geographic distribution of agricultural production.

Looking forward to a demand for wheat requiring a somewhat smaller area even by 1960 than was in cultivation in 1929, a contraction in wheat acreage principally in two belts may be expected. The western edge of the wheat-producing region in the Great Plains has probably expanded into certain areas too dry and otherwise hazardous for economical production. Consequently, abandonment is taking place in parts of these areas, the land returning to range. This tendency may go further. As indicated below, national land policies are now being developed with a view to facilitating the necessary readjustment. In addition, increased acreage of corn and other feed grains may be expected to replace a part of the present wheat acreage in the eastern Dakotas, Nebraska, Kansas, and Oklahoma, as a result of the development of improved varieties of corn and other feed grains that are better adapted to the eastern part of the wheat-producing region and of the increasing requirements for meat resulting from growing population. Not much change in wheat acreage is expected in the Corn Belt because of the place of wheat in the rotation.

With a probable increase in demand for land for growing corn, it seems likely that the downward trend in corn acreage in the general farming region of Missouri, southern Illinois, southern Indiana, Ohio, and Kentucky will be slowed up. Increased corn production, however, may be expected mostly in the central and northwestern Corn Belt—where with favorable prices a more intensive utilization of land is likely, primarily in the form of higher yields of grain crops, especially corn, through the use of lime, phosphates, and high-yielding legume crops in the system, the latter to serve partly as rotation pasture of heavy carrying capacity and partly as an effective source of supply of humus and nitrogen—and in the eastern part of the wheat-producing region as indicated above.

The northern, eastern, and southern margins of the Corn Belt will probably respond to any increased demand for dairy products, resulting in the production of more pasture and forage crops with relatively little change in corn production.

A further decline in the acreage of hay and feed grains in the New England States may be expected, until the hay produced is only slightly in excess of the amount needed (together with purchased concentrates) to supply the cities with fluid milk. The Great Lakes States may be expected to continue crop production at about the present levels.

With the probability of some eventual increase in the land devoted to cotton production, new cotton lands can be expected to develop chiefly in the dry western areas where native pasture lands are available and areas where prospective or contemplated irrigation projects will make water available on arid land. Reclamation projects and flood control may increase somewhat the land available for cotton in the Mississippi Delta. It is probable that the older cotton-producing regions will continue cotton production at not far from their present level, although the farmers may have to give increased attention to soil-building crops in order to maintain cotton yields. This might mean some reduction in acreage on highly erosive lands.

In summary, it seems likely that the land for increased feed production will be secured principally by a further concentration of corn and small grain production in the central Corn Belt and by some westward movement of the feed crops. It appears likely that crop acreage, especially of grain crops in the eastern and northeastern States, will, in general, decline somewhat further and that part of the wheat acreage in the more arid sections of the Great Plains will revert to range.

If, however, a tardy recovery of industry and restoration of industrial employment necessitate a continued tendency toward self-sufficiency in agriculture, the increased regional specialization suggested above may be materially retarded.

Land Available for Range

The 884 million acres of range land are made up of 550 million acres of nonforest ranges chiefly west of the 100th meridian and 334 million acres of forest ranges, 43 percent of which is in the West, 45 percent in the South, and 12 percent in the central and northeastern parts of the United States. About 309 million acres are publicly owned or controlled, and 575 million are privately owned.

These lands contribute substantially to production of approximately 36 percent of the Nation's cattle and calves, 57 percent of the sheep and lambs, and 73 percent of the wool. They also support over 1 million big-game animals and innumerable game birds and other wildlife. Range lands occupy about 75 percent of the watershed area west of the 100th meridian. While the amount of water furnished acre for acre by these lands for irrigation and power is small as compared to that from western forest lands, range depletion followed by abnormal erosion is threatening the permanency of irrigation and the dependent communities.

Because of private misuse, approximately 415 million acres, or three-fourths of the western ranges outside the boundaries of national forests and other publicly administered reservations, are now subject to depletion of cover, erosion, and economic instability. These are largely lands in the arid and semiarid foothills, plateaus, and valleys. Two-thirds is privately owned. One-third is in the public domain and intermingled State, county, and other public unregulated land.

The principal private land tenure conditions resulting in range deterioration are:

1. About 30 million acres adjoining ranch headquarters and permanent watering places which are depleted from 50 to 90 percent.

2. Several million acres adjoining settlements in the Southwest upon which practically all forage has been destroyed.

3. Nearly 190 million acres depleted from 40 to 50 percent because of overstocking—due to ignorance, the desire to reap a temporary benefit, or in an effort to offset high fixed charges. A crisis ensues where periodic droughts occur.

4. Some 25 million acres burned periodically to open dense brush stands or in the hope of improving forage.

5. Over 15 million acres of submarginal dry farms now abandoned to wind and water erosion.

Range control has been prevented by intermingled ownership of unregulated public and private lands resulting from alternate-section land grants to railroads and other corporations, and from scattered homesteading. Under arid conditions a section of land is insufficient to support a profitable livestock herd. What but serious depletion could result from such land tenure?

A high percentage of the 149 million acres of forest ranges in the South are grazed by settlers who do not own or lease the land. Their attempts to improve forage conditions by fire have seriously damaged forest and soil values.

The 1934 drought is indicating that the 15 million acres of dry farms abandoned in the past will be greatly augmented in the next few years. It is probable that an additional 15 to 25 million acres of once cultivated land will revert to range during the next decade.

Relation of Crop Acreage Under the Emergency Program to Acreage Requirements on a Long-Time Basis

The examination of the nature and extent of the crop acreage that it is desirable to maintain in the future may be viewed from two distinct vantage points: First, that of the immediate future, perhaps up to 5 years, and second, that of the long-time point of view. Each view complements the other, and involves a consideration of a somewhat distinct set of problems.

The former point of view is necessarily that which characterizes the present emergency program, for it is concerned with immediate problems. Having its inception at a time when a virtually unprecedented combination of circumstances confronted agriculture, the emergency program has had to face immediate problems.

The situation to be met found a tremendous disparity, much of it of recent origin, between prices of farm products on the one hand and prices of commodities purchased by farmers and service charges on fixed obligations on the other hand. The price disparity was associated with huge surpluses that had accumulated over a period of years, with high and rising barriers impeding international exchange of goods, and a local market with greatly reduced purchasing power. Under the conditions, it was imperative that prices be raised to some reasonable relationship with fixed obligations and prices of nonagricultural commodities, and that the accumulated surpluses be reduced to manageable proportions. From this standpoint our area in cultivation has been and still is somewhat excessive with normal yields, although excessive surplus stocks have been materially reduced as a result of the crop adjustment program and the abnormal drought of 1934. With the passing of the present emergency, it will continue to be necessary to follow closely the immediate problems affecting agriculture. To shift from the short-time to the long-time point of view will necessitate an intermediate type of program.

The long-time point of view requires a different perspective. It is appropriate that less emphasis be placed upon price relations, not only because successful price forecasting for 5, 10, 20, or 30 years in the future becomes increasingly impossible, but also because a gradual change in the price levels is much less disturbing than a change of similar amount occurring within a short space of time. More properly, attention centers on the extent of area that will be needed to provide food, feed, and agricultural raw materials for the population of the Nation in the future and to provide for such exports of farm products as we are likely to sell.

In addition, attention is properly directed to the human relationships involved in agricultural production, and to maintaining agricultural land in such condition that the food supply will not be jeopardized either through soil deterioriation or otherwise. The solution to the former problem may, and probably will, involve the retirement from production of certain areas and the reestablishment of the population concerned. Such action is designed to anticipate the changes that would normally occur in these areas, and to facilitate their accomplishment in such a manner as to prevent the blighting of individual lives and of the local social organization that often develops in underprivileged regions. The various estimates above indicate prospective increased net requirements of arable acreage amounting to 20 million acres by 1950, and to 30 million acres by 1960. In considering the problem of meeting these requirements it will be necessary to allow for the fact that a considerable proportion of our present farming lands are so poor that they should be retired from agricultural production. The elimination of this poor acreage, the amount of which has been estimated in an earlier section of this report, will necessitate replacements to meet long-time requirements.

Coordinated with the retirement of certain areas must be plans for effecting, with the least disturbance possible, the increases and shifts in acreage of various crops as population increases, export markets open or close, and as technique progresses.

SECTION II

III. FOREST LAND REQUIREMENTS AND AVAILABLE RESOURCES*

General Nature of Concept of Requirements in Respect to Forests and Forest Products

Before the depression American forests were a source of wood products valued at 2 billion dollars a year. In mills and woodworking industries 1,300,000 workers were normally employed, who received some 1½ billion dollars of wages annually. As a source of products indispensable to daily life and as a source of employment the forest is a major component of national wealth. Under long-time planning the forest will produce these benefits in more orderly fashion than it has in the past. Instead of transitory employment and transitory industries in particular areas, it will afford regular and dependable employment by furnishing continuous supplies of raw materials to permanent industries.

Forests serve a number of important purposes other than the production of timber, and it is important that these purposes be kept in mind in a broad national program of planned land use.

The forest exercises far-reaching protective influences over land and water resources. It holds the soil against erosion, equalizes stream flow, delays melting of snow, and helps to maintain ground-water supplies for wells and springs. Over hundreds of millions of acres the protective function of the forest is of paramount importance, yet this function interferes very little with regulated timber cutting and other necessary forest uses. Under a more plan-wise treatment of forest resources, watershed conditions will be improved and forests will be restored to areas where these conditions are highly important. Through scientific forestry, trees should be established upon suitable locations in the open plains for the beneficial influence they exert on wind velocity, humidity, and temperature, as well as for the landscape value.

Forests provide habitat, feeding ground, and refuge for game animals, fur-bearers, and birds. They maintain favorable stream conditions for fish. Thus wildlife resources are conserved for the inspiration and education of the nature lover and the enjoyment of the sportsman. Under sound management these resources can be greatly increased at little or no sacrifice of the more strictly economic uses of the forest.

Under proper regulation much of the forest area may be grazed by livestock, yielding millions of dollars' return in the form of meat, hides, and wool.

The recreational value of the forest is assuming greater and greater importance in American life. It

* The following persons in the Forest Service have contributed material which has been utilized in the preparation of this: R. D. Forbes, E. A. Foster, W. H. Gibbons, F. J. Hallauer, R. F. Hemmingway, F. A. Ineson, L. F. Kneipp, H. R. Kylie, G. H. Lautz, T. J. Mosley, E. S. Shipp, Helen B. Smith, and J. M. Witherow.

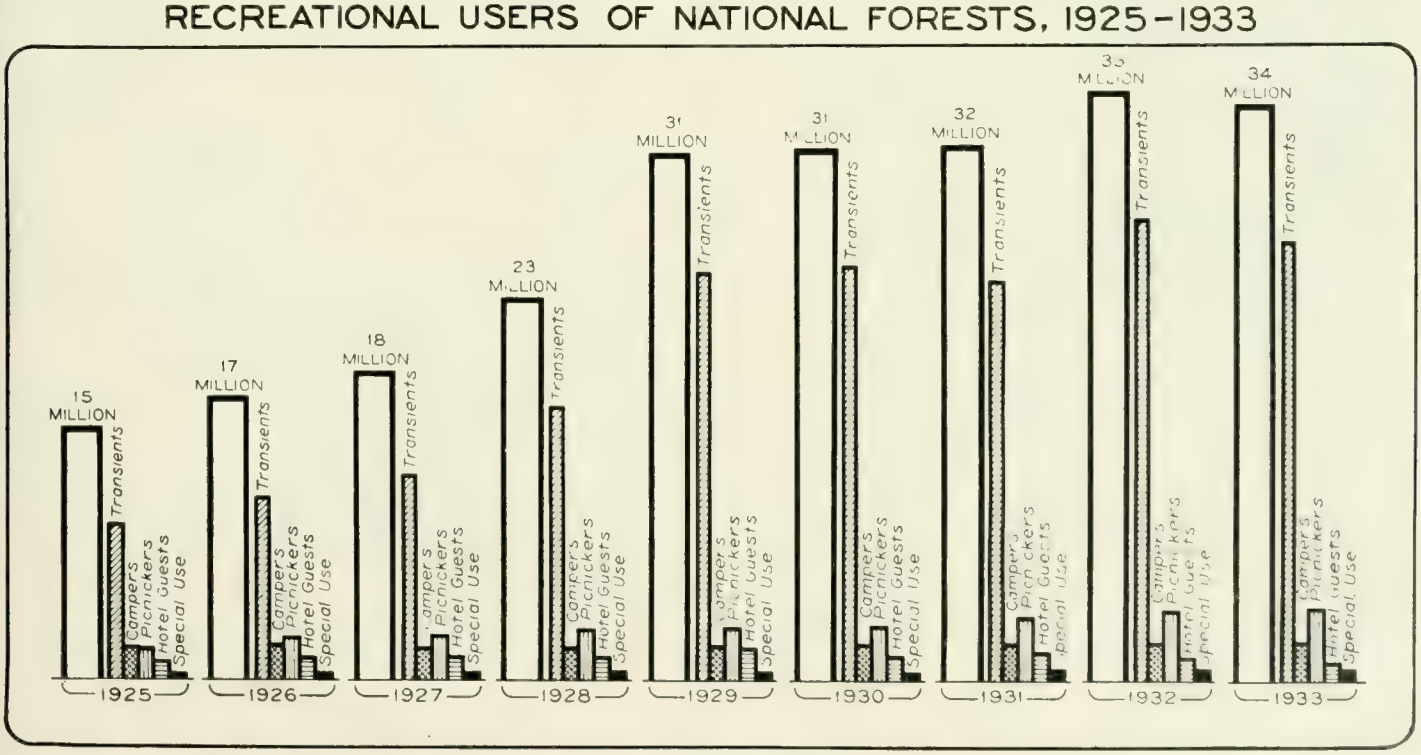

FIGURE 22.—Recreational users of the national forests increased rapidly between 1925 and 1932. Thirty-four million persons enjoyed the recreational facilities of the national forests in 1933.

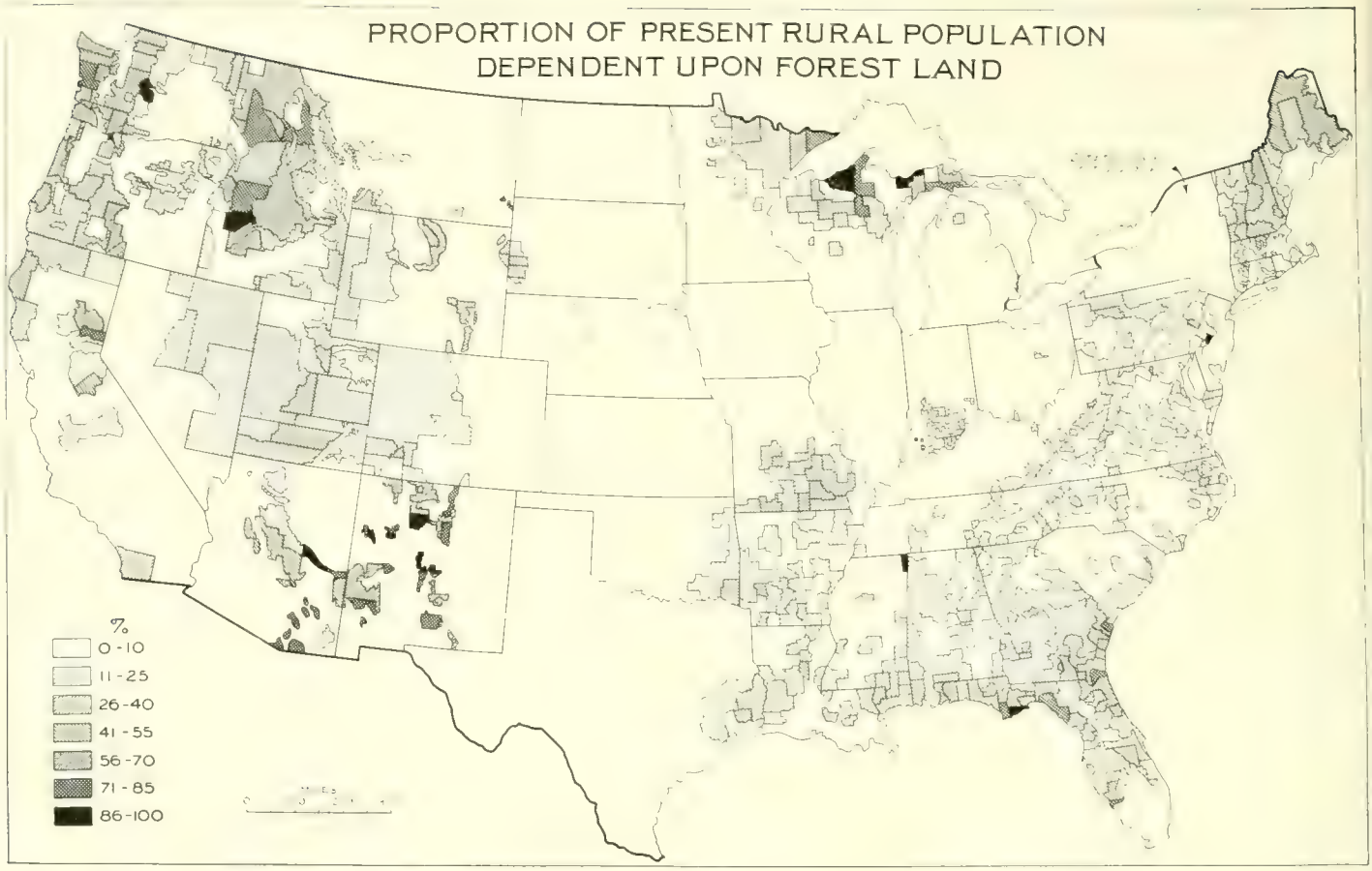

FIGURE 23.—The proportion of the present rural population which is dependent upon forest land within the area covered by the statistical inquiry of the Forest Service.

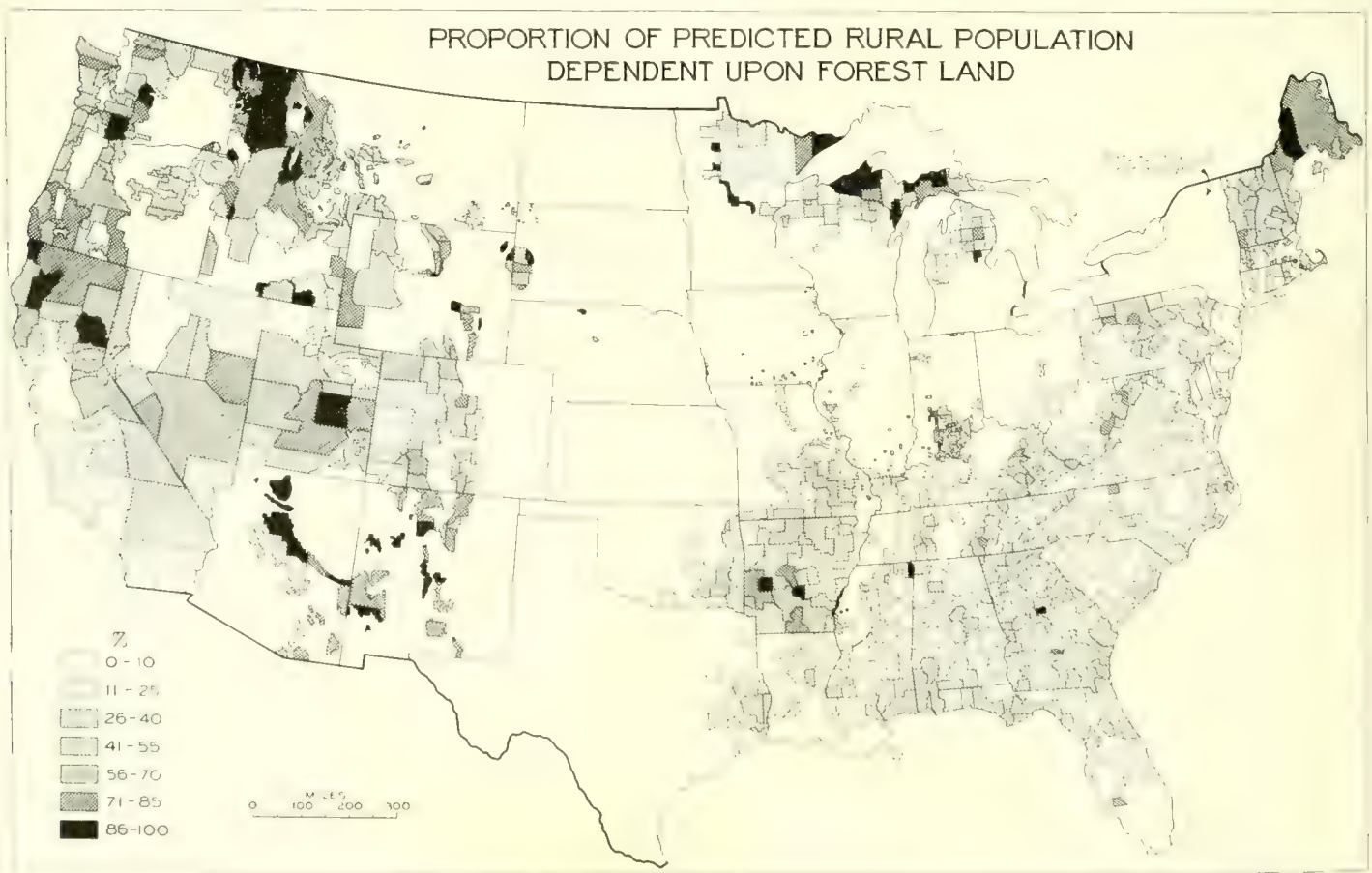

FIGURE 24.—The proportion of the predicted rural population which will be dependent upon forest land if the recommended forms of use are permanently established in the area covered by the statistical inquiry of the Forest Service.

confers benefits of health and inspiration on millions, and it yields large monetary returns to the population within or adjacent to the areas so used. Some of the social values of forest lands, particularly esthetic, recreational, and inspirational values, obviously cannot be measured in economic terms. Much work is needed to develop fully and realize these values. (See fig. 22.)

The social values inherent in forest work are not as generally recognized as the social values of forest recreation, but they are no less real. The rugged occupations of logging and lumbering develop substantial qualities. It is probable that under the intensity of management recommended by the field organization of the Forest Service, hereafter outlined, the number of workers could be approximately doubled. Figures 23 and 24 show the distribution and density of population now dependent on forests and the population that could be supported if the above-mentioned intensity of management were realized. As pointed out later, however, such a costly program might not be justified.

The forest program should also be devised with due reference to the vital importance of local forests to the support of nearby rural communities, affording a basis for industry and for employment in woods and mills, a market for farm products, and a source of income to local governments. The restoration of extensive areas of depleted forests promises employment in the woods for thousands of workers, a basis for the establishment of planned forest-farm communities, and the eventual economic rehabilitation of large sectors of the country now stricken by forest bankruptcy and its companion evil, tax delinquency.

Minor forest products or by-products include Christmas trees, mistletoe, nuts, fruits, sugar, sirup, tan bark, cascara bark, and upholstery stuffing material (such as mosses and tillandsias).

Another value of forests is in providing windbreaks. Acting upon experience gained in Russia, which indicates that appreciable benefits can be derived from planting timber strips upon the prairies, work has been started to establish extensive belts of timber on the American plains, where species adapted to the semiarid climate are to be planted in strips across the path of prevailing winds. According to experts of the Forest Service, such plantings contribute to reducing the wind velocity at the ground level, preventing wind erosion, reducing evaporation from the soil, and maintaining a relatively higher humidity near the ground.

Forestry is closely interrelated with agriculture, and should be even more closely coordinated with it. It provides the farmer with fuel and building material and a supplementary source of income. It safeguards farm water supplies and water for irrigation. Farmers in timbered regions are benefited by a stable forest economy and are among the principal sufferers when these conditions are lacking.

In general then, the Nation's forest land requirements are not measured merely by its requirements for timber and other forest products, since other social values incident to the growth of trees on the land are of essential importance. In fact, in some areas timber production may frequently be less important than other objectives in land management.

Timber Consumption and Requirements in Relation to Available Timber Supplies

A study of timber statistics shows a close correlation between per capita consumption and the available supply of timber. It is proper to point out, therefore, that the following estimates of requirements for timber reflect largely the assumption that quantities used under normal conditions, with proper allowance for existing trends, constitute a basis for determining requirements. The fact is that timber requirements, as they may determine land requirements, are in large measure influenced by the available abundance or scarcity of timber and of the land available for producing it. A number of civilized countries of Europe employ many times less timber per capita than we do, while several countries where timber is unusually abundant have a larger per capita consumption. It is a fair assumption that we would not be using so much timber per capita if it did not serve useful purposes, and therefore it is fair to assume that we should provide for the maintenance of that volume of consumption if the land can be spared from other uses and if the cost of establishing and maintaining the forests does not out-run the value of the product, with due consideration also for the less tangible economic and social values of forests hereafter discussed. In a very real sense then, our requirements are a function of the availability of the land and timber-growing stocks. This is considered in a later section.

The trend of lumber consumption reached a peak in 1906 and has been downward, contrary to the trend of manufactures and of population, since that time. The decline from 43 billion board feet of lumber used in 1912 to 36½ billion board feet in 1929 is almost entirely reflected in the decline in lumber used directly in construction, a decline of almost a billion feet in factory use being offset by a comparable increase in sash, doors, and millwork.

Decline in construction is thought to be largely accounted for by a loss of 9½ billion feet in rural construction, which was partially offset by the increase in urban construction that accompanied the building boom of the late twenties. It is believed that rural construction may be expected to recover to about 10 billion board feet annually, that factory products taken together will continue with little change, but that urban con-

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struction, including sash, doors, and millwork, will probably not require more than about two-thirds of the amount used in 1928. The tentative total normal lumber consumption, given an adequate supply of timber to draw upon, is therefore set at 32 billion board feet annually.

Although the use of wood for fuel has declined materially during the past few decades, there are indications that a low point has been reached. Of the 61 million cords estimated as the yearly fuel requirement, 42 million are charged as direct drain on the commercial forests.

The United States is at present supplying less than half of its total requirements in pulpwood. Use of wood for paper and other pulp products continues to increase, and total future requirements are estimated at 25 million cords per year. There is considerable probability that new technical developments, the gradual restoration of our eastern forests, and the progressive depletion of the more accessible Canadian supplies may ultimately increase the proportion of pulpwood supplies obtained from domestic sources.

Trends in miscellaneous forest products offset each other to a considerable extent; and since statistics for some items are almost entirely lacking, prospective requirements are set at the average of recent consumption, namely 2½ billion cubic feet annually.

For the future it is contemplated that losses from forest fires will be reduced one-half and losses from insects, disease, etc., by one-fourth the present losses.

When all the figures are brought together on the common basis of cubic feet, the total prospective timber requirement, including the allowance for loss, is estimated at about 16½ billion cubic feet annually, which happens to be roughly equivalent to the annual drain in the forest for the period of 1925 to 1929. The figures are summarized in table 10.

TABLE 10.—*Tentative normal timber requirements compared to average drain for 1925–29, by item of use or drain*

Item	Average annual drain 1925–29		Tentative normal requirements	
	Million bd. ft.	*Million cu. ft.*	*Million bd. ft.*	*Million cu. ft.*
Lumber	38,000	7,371	32,000	6,207
Pulpwood	1,474	589	4,363	2,623
Fuel wood	7,047	4,003	7,047	4,003
Other products	8,121	2,532	8,121	2,532
Total commodity use	54,642	14,495	51,531	15,365
Fire losses	1,390	871	695	436
Losses from insects, disease, wind, drought, and naval stores operations	3,402	985	2,552	739
Total drain on forest	59,434	16,351	54,778	16,540

It should be repeated, however, that the above estimates are predicated largely on recent levels of consumption (mainly prior to the present depression) and the previous trends. These consumption levels and trends reflect in large degree the relative abundance and cheapness of forest products. In the years just preceding 1929, as well as during the present depression, cheapness was in part due to the liquidation by timber owners of excess holdings of stumpage. If the general outlook emphasized in the Copeland Report for a period of serious scarcity of timber is realized, this might result in material modifications in the Nation's consumption standards relative to forest products, including the development and adoption of substitutes. These changes might continue into a subsequent period of greater abundance if such a period should result from national policies favorable to timber production.

The Forest Land Area and Its Management in Relation to the Nation's Timber Requirements

The problem of meeting the Nation's timber requirements should be approached from the standpoint of ascertaining what measures of forest management are required to obtain from the available area of land a sustained yield of timber commensurate with the prospective requirements.

Timber growth under present conditions totals less than 9 billion cubic feet in timber of all sizes and 11¾ billion board feet of saw timber. These rates of growth would be entirely inadequate to supply the volume of consumption indicated in the above table. In the period 1925–29, growth amounted to only about half the total forest "drain" in timber of all sizes and one-fifth of the saw-timber drain. Although the current rate of cutting may continue for some time in the West, thus supplying a major portion of the Nation's timber needs, drastic reduction of cutting seems inevitable in the East. The situation is especially critical in the Lakes States and Central and Southern regions.

Regional sustained yield on saw-timber rotation should be the objective of forest management in meeting the Nation's timber requirements, although obviously such an ideal can be only gradually realized in remaining areas of virgin forest and the extensive areas of land harvested in recent years by clean cutting methods. A combination of intensive forestry, extensive forestry, and simple protection is believed to be the way in which the problem should be met. After calling attention to a minimum plan which would not meet the prospective requirements, and an ideal plan at the other extreme which would devote to timber production all the land available, and also would represent a possible ultimate limit in developing forest-growth potentiality, the writers of the Copeland Report present an intermediate and more nearly realistic program commensurate with estimated timber requirements. This plan envisions a prospective annual

growth of about 17¾ billion cubic feet of saw timber, by the following allocation of an assumed available area:

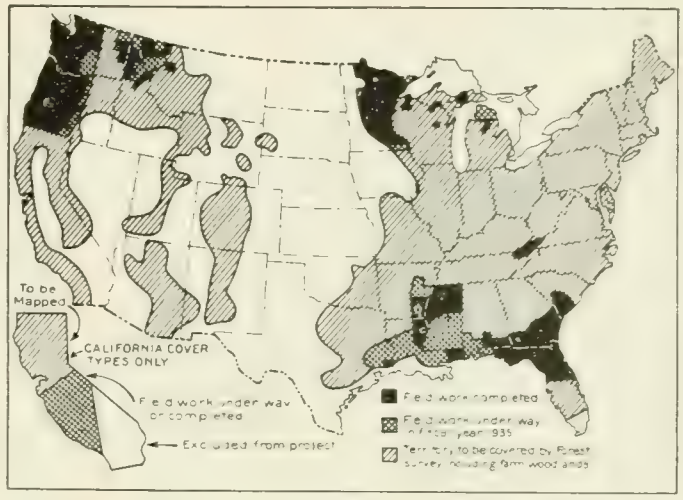
Type of management	Areas	Total annual yield
	Million acres	*Million cubic feet*
Intensive forestry	70.0	4,670
Extensive forestry	278.9	11,740
Protected, relatively favorable for timber production	40.7	840
Protected, relatively unfavorable for timber production	69.7	510
Open	49.3	
Total	508.6	17,760

The above calculation is based upon consideration of timber supplies only.

For the present report the Forest Service, through its field organization and associated agencies, made an estimate by considering county by county the local needs and potentialities of specific areas throughout the forested portion of the United States. This method of estimate led to the conclusion that there should be intensive management on 295 million acres, extensive management on 150 million acres, and protective management on 64 million acres. The increased proportion of the acreage recommended for intensive management is due to the consideration by the reporting agencies of the economic and social needs of populations in separate sections of the country made up mostly of forest land. In many parts of the forested sections of the Nation the restoration of forests to production would contribute materially to the solution of acute social and economic problems. Considered collectively, total production might exceed total needs, but in certain regions, particularly those near centers of population, it would not be excessive. Managed for timber alone, without special provision for wildlife and recreational values, the recommended management would produce about 20 billion cubic feet per year when built up to full productivity. Under a modified plan of management, which would give greater consideration to recreational and wildlife values to the extent of interspersing shrubs and other plants of value for wildlife food and cover among the timber species to the extent of 5 percent of the total forest areas, the prospective growth would be 18½ billion feet. If consumption of timber should fall materially below the above estimates, greater emphasis could be placed on game management.

The detailed growth budget under the above assumption would be as follows:

Type of management	Area	Growth
	Million acres	*Million cubic feet*
Intensive	295	14,750
Extensive	150	4,500
Protective	64	320
Total	509	19,570


To be Mapped
CALIFORNIA COVER TYPES ONLY
Field work under way or completed
Excluded from project
Field work completed
Field work under way, as of end year 1935
Territory to be covered by Forest Survey, including farm woodlands

PROGRESS OF THE NATIONAL FOREST SURVEY
(AS OF SEPT. 30, 1934)

FIGURE 25.—Progress of the National Forest Survey inventory of timber resources, as of September 30, 1934. Authorized by the McSweeney-McNary Act of 1929, and the largest comprehensive timber survey ever undertaken. When completed it will afford the most accurate basis yet obtained for extensive forest planning.

With a 5-percent deduction for small areas to be devoted to nontimber species throughout the forest area for wildlife production, the net estimated growth is 18,591,500,000 cubic feet.

The reason that this estimate does not exceed the previous Copeland Report plan by a greater amount is partly because the original plan contemplated a more intensive type of management on the cream of the forest land and partly because of the additional provision for wildlife. By quadrupling the area recommended for intensive management, that type of management would be extended to less productive forest land and the average growth rate for the intensively managed land would become correspondingly less. A relatively lower intensity of management also is contemplated, thus further reducing the prospective yield per acre. A relatively lower productivity is also assumed for extensive areas designated for protective management. Even if the management program assumed in figures just given should be adopted *in toto*, the estimated annual yield of 18½ billion feet could not be attained in less than 40 years.

These estimates of potential growth are based upon information compiled from many sources. It is the best information obtainable at the present time, but is not comparable, of course, to the more carefully collected data being obtained through the National Forest Survey now in progress, which when completed will provide a much-needed basis for forest planning. (See fig. 25.)

However, the above estimates, both for forest acreage and potential yields, should be looked on as maxima. Several further qualifications should be considered. A growing stock or volume of productive timber of at least 634.1 billion cubic feet would be required to maintain a sustained yield of the indicated amount, whereas

Distribution of Commercial Forest Land Outside Indian Reservations and Farms.

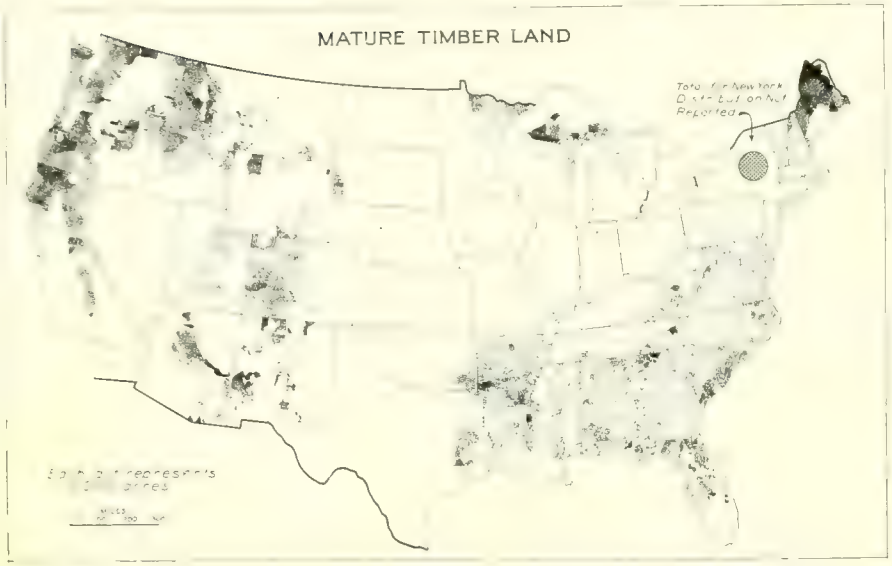


FIGURE 26.—Distribution of land supporting timber of such size as to be currently merchantable for the major product to be taken from the area, does not include stands otherwise classifiable only as second growth, but cut primarily for so-called minor products, such as chemical distillation, fuel wood, mine props, posts, etc.

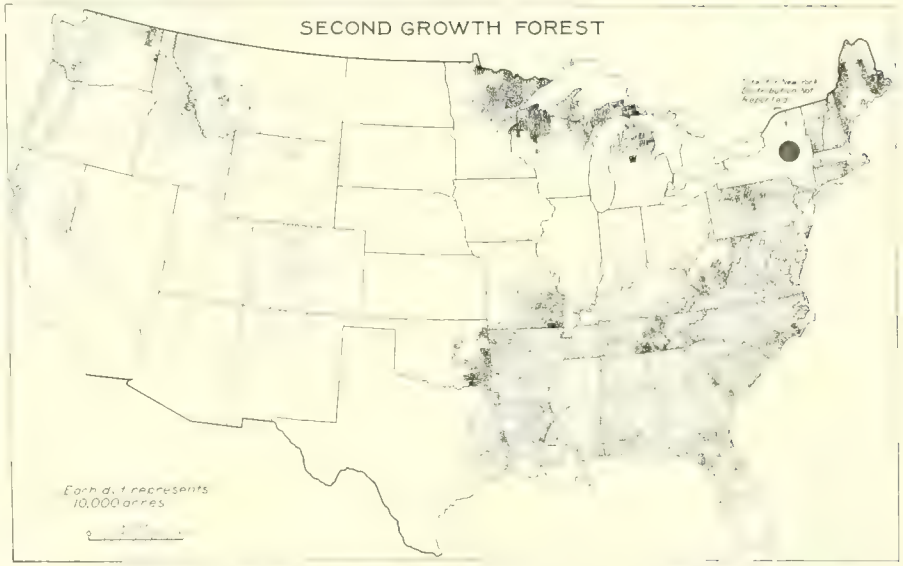


FIGURE 27.—Distribution of land supporting stands below mature timber classification, but above 2 inches average diameter at breast height and averaging more than 100 trees per acre.

FIGURE 28.—Distribution of land supporting an average of more than 100 trees per acre less than 2 inches in diameter at breast height.

FIGURE 29.—Distribution of lands supporting less than an average of 100 trees per acre.

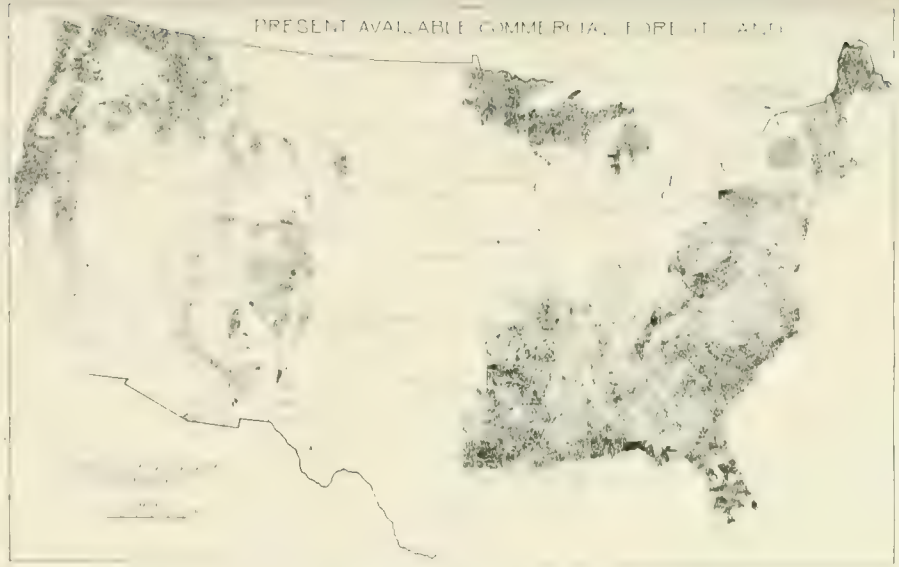


FIGURE 30.—Distribution of land supporting or available for and capable of producing forest products outside Indian reservations and farms. Areas withdrawn from commercial use, as in parks, are not included.

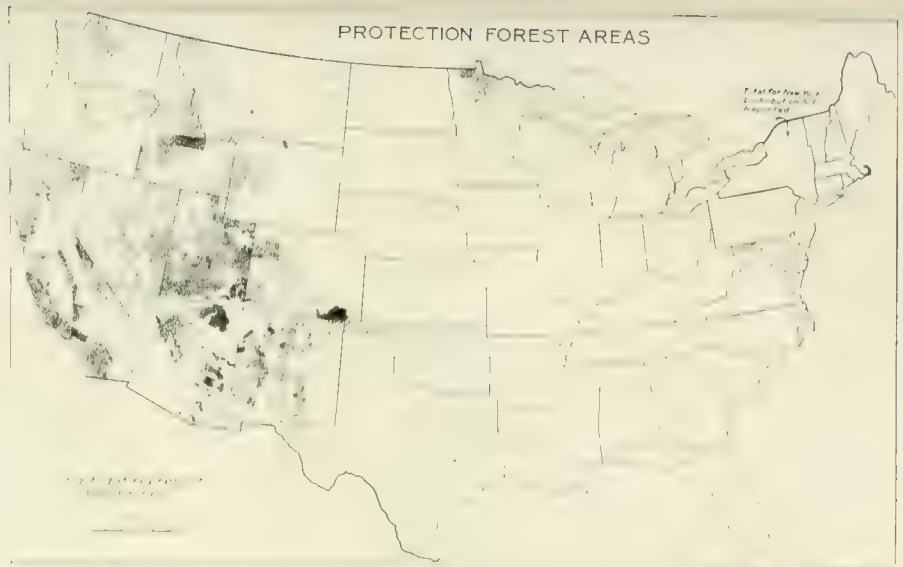


FIGURE 31.—Distribution of all lands supporting or capable of supporting a forest cover essential for protective purposes, but without commercial value and not falling in any other classification. The natural cover will, under normal conditions and when protected from fire, reach a minimum average height of 6 feet and a density that will provide ground shade comparable to that in a timber forest.

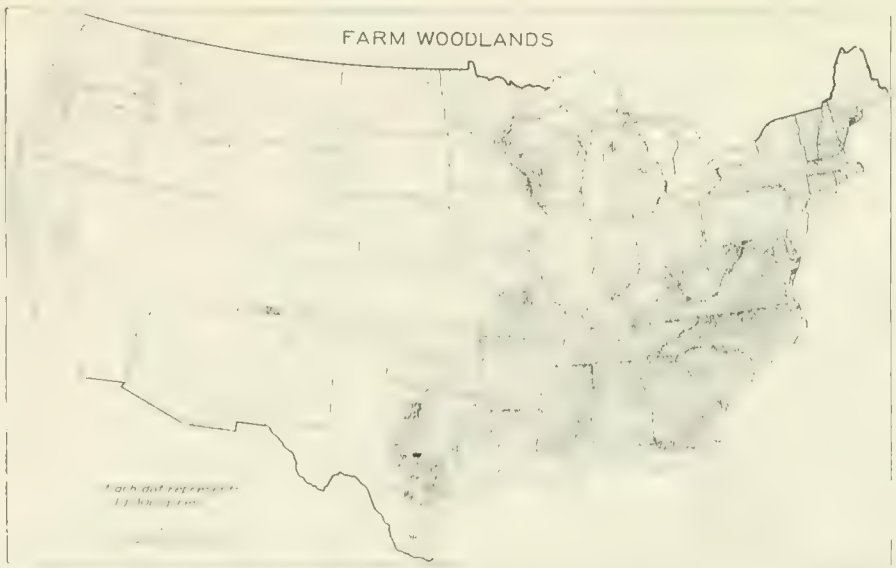


FIGURE 32.—Distribution of "woodland pasture" and "woodland not pastured" as compiled from the 1930 Census of Agriculture. Includes all "Farm Woodlots" or timber tracts, natural or planted, and cut-over land with young growth; but excludes chaparral and woody shrubs.

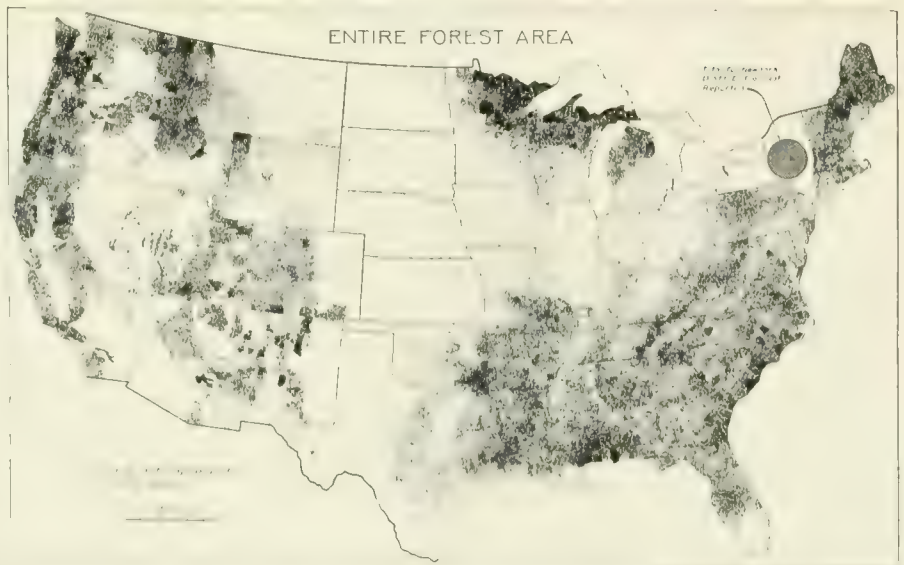


FIGURE 33.—Distribution of all lands supporting or available for and capable of supporting a forest cover, including forested portions of Indian reservations and parks.

existing stands total only 486.8 billion cubic feet. In the New England and Middle Atlantic regions the present growing stock is about 0.7 of that which would be required. In the Lakes, Central, and Southern sections present stocks would have to be increased 2½ times. In the West the existing stand is almost twice as great as the minimum needed, but owing to the large volume in mature, nongrowing forest, the surplus of growing stock is only apparent. In the case of timbered areas near centers of population, game and recreational management must receive increased emphasis more or less to the detriment of timber growth.

Furthermore, some of the better land included in the 508.6 million acres assumed to be available is likely to be employed for cultivation, although it is doubtful if this will exceed 20 million acres, with perhaps an additional 20 million acres of associated pasture. Again, extensive areas included in the total are not naturally well adapted to the growth of timber because of poor soil, unfavorable climate, or remoteness from centers of population and transport facilities. The estimates of the proportion of the total forest area that is adapted to intensive cultivation was determined largely in terms of local considerations. It is not improbable, however, that in much of the area cost of restoration and maintenance may be found to exceed the value of the benefits, even when the various social values mentioned above are duly considered. Economic considerations may dictate an extensive type of management over a large proportion of the forested area, with greater emphasis on soil protection, game, and recreation and less emphasis on timber production than is assumed in the above estimates. The natural growth that comes in a cut-over area, though of no value for commercial timber, may serve the purposes of soil protection and watershed control, as well as a habitat for game and for the type of recreation likely to be resorted to in areas remote from centers of population—principally hunting and fishing.

Value of Forests in Reducing Erosion and Regulating Stream Flow

As suggested above, forests serve a number of purposes of outstanding significance in national welfare, in addition to provision of timber and other tree products. For example, out of a total wooded area of 615 million acres in the United States the forest on 308 million acres exerts a major influence on stream flow and erosion, and on an additional 141 million acres it exerts a moderate influence. The reforestation of probably 22 million acres of abandoned crop and pasture land is considered necessary to prevent continued disastrous erosion. The forest land on which forests should exert an important influence in the conservation of water and the prevention of erosion may therefore be placed at about 471 million acres. Of this, 11 million acres is nonrestocking forest land in need of replanting.

In many large areas where precipitation is heavy the use of land to restrain ungoverned run-off, erosion, and its various consequences is already paramount in importance to all other land uses. The management of three-quarters of our forest land, at least with a view to its watershed protective influence, therefore should be an important segment of a comprehensive land use plan.

Table 11 indicates the acreage of lands now forested which are of major or moderate influence for watershed protection in critical areas of the country. This table also lists the areas in each region on which forest planting is required to insure proper protection against erosion and excessive run-off. (See also fig. 31.)

TABLE 11. *Lands in the United States to be kept in forest for watershed protection*

Region	Forest areas of important watershed protective influence				Areas requiring planting
	Total	Major influence	Moderate influence	Abandoned agricultural land to be restored to forest	
	Million acres	*Million acres*	*Million acres*	*Million acres*	*Million acres*
Mississippi bluff lands and silt loam uplands (Minnesota, Wisconsin, Iowa, Illinois, Missouri, Kentucky, Tennessee, Mississippi, Arkansas, Louisiana)	6.3	4.6	--	1.7	0.65
Piedmont and upper coastal plains (Maryland, Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi)	57.6	40.0	10.0	7.6	2.60
Northeastern drainages (New England, New York, Pennsylvania, Maryland)	31.0	17.0	13.0	1.0	.40
Appalachian Mountain chains (New York, Pennsylvania, West Virginia, Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia)	42.8	38.0	2.0	2.8	2.50
Ozark-Ouachita (Arkansas, Oklahoma, Missouri)	25.6	23.0	1.0	1.6	.50
Pacific slope dense forests (Montana, Wyoming, Idaho, Washington California)	19.0	17.0	2.0		.20
Ponderosa lodgepole-pine belt (Wyoming, Colorado, Utah, New Mexico, Arizona, California)	110.0	75.0	35.0		.38
Semiarid woodlands and brush lands (California, Nevada, Arizona, New Mexico)	85.0	60.0	23.0		
Other regions	93.2	33.4	52.7	7.1	4.10
United States	470.5	308.0	140.7	21.8	11.33

Land Available for Forests

Of 495 million acres of forest land held for commercial purposes, 189 million acres bear timber of saw-timber size, 121 million acres are stocked with timber, and 83 million are classed as poor to nonrestocking. An additional area of 11 million acres is withdrawn from commercial use for timber production

in parks and other reservations. Approximately 109 million acres are classed as chiefly valuable for uses other than timber and include piñon-juniper forests, chaparral, alpine types, etc. The total forest area is estimated at 615 million acres.

Figures 26 to 33 inclusive show the distribution of these classes and also the total forest land. A large part of this forest acreage held for commercial purposes is lying idle, except for incidental use for recreation and wildlife, and the production of timber which has established itself voluntarily and which is growing without attention or care.

The additional land that might be devoted to forest use includes a number of classes. It is estimated roughly that 20 million acres, more or less, of farm land may become available for forest use or some other protective use by 1950, although adequate measures to prevent further serious deterioration would facilitate the continuance in cultivation of part of this. Gullied areas on supermarginal farms that should be planted to trees to check further injury comprise another possible source of addition to the forest areas. It may be possible, however, to employ pastures rather than forests as a means of protecting some of these lands from erosion. A considerable acreage in prairie States might also find its highest social use if planted to forest shelter belts. Forestry knowledge is now sufficiently advanced to undertake successfully such plantings on the Great Plains east of a line corresponding approximately to the line of 18 inches rainfall. There is an aggregate plains area of about 200 million acres east of this line, of which at least 3 million acres should be devoted to tree shelter belts. As knowledge becomes available on timber planting on the western and drier portions of the plains, similar plantings may appear desirable on approximately 3 million acres within the approximately 200 million acres of the Great Plains lying west of the limit of the plantings which are contemplated for the immediate future.

Relation of Acreage Requirements to Acreage Available for Forest Use

The facts cited above indicate that the acreage available for forest use, if placed under the type of management recommended by the field workers employed in the reconnaissance survey would exceed by a safe margin the estimated current normal consumption of timber, and at the same time permit devoting some of the forest area to game feed and cover plants interspersed among the timber species. It must be recognized, however, that at least 40 years would be required to build the forest up to this productivity; that present growth is less than 55 percent of the consumption in terms of cubic feet in the years just preceding the depression, and only 20 percent of the consumption of saw timber. This points inevitably to a deficiency of timber supply, judged in terms of present standards of consumption, during the interim between the exhaustion of virgin stumpage and the realization of full yields from the second-growth forests. When the second-growth forests come into full production lumber prices will again decline and consumption will increase, though it may not return to the level that would have prevailed had not standards of consumption been forced to adjust themselves to scarcity. In anticipation of the period of short timber supplies intensive silvicultural treatment should be concentrated first on the second-growth stands occupying the best sites, with the objective of crowding these stands to maturity as rapidly as possible.

Commercial timber use is now subordinated to recreational values on about 11 million acres of forest land. The maximum estimate of 309 million acres available for commercial forest production excludes an additional 34 million acres which apparently should be dedicated to specialized recreational use, bringing the total prospective withdrawal for specialized recreation to 45 million acres. However, suitable provision for recreation should be made one of the joint uses on the forest area to be devoted to general forest use, as well as on the 45 million acres proposed for specialized recreational use.

It was shown above that under the intensity of management assumed in the field survey, 5 percent of the commercial forest land could be devoted exclusively to cover and food species for wildlife without unduly reducing the production of commercial timber supplies. To be of maximum benefit, the acreage so used should be widely interspersed through the forest area, in patches often only a fraction of an acre in size. The entire forest area thus would become a prolific producer of game, fur, meat, and other wildlife values. A more adequate provision for game would tend to reduce somewhat the volume of timber growth. Therefore the relative importance of the two competing uses in particular areas would be a deciding factor.

SECTION II

IV. RECREATIONAL LAND REQUIREMENTS[1]

General

It is next to impossible to measure recreational requirements in terms of land because different kinds of recreation have entirely different space requirements, and because most areas of land have or may have some recreational utility either as a primary or by-product use. Recreation or "re-creation" for one man may consist in occupying 3 square feet while reading a book, while for another it may require thousands of acres of wilderness. Autumn color and the compact organization of a New England village may draw thousands of visitors to New England on recreation bent with practically all of the scenery in private ownership, while in the great national forests of the West, the public can enjoy life in the open on public property without interfering with the commercial production of timber.

The common habit and desire of people with either means or leisure time to escape from the normal occupations and confining duties of city life have sent millions annually to the mountains, lakes, and beaches for their vacations and spiritual refreshment. Practically every State in the Union has large areas devoted primarily to recreation which are held in private ownership, and in many places this recreational business constitutes the principal source of income for the permanent inhabitants. The recreation industry in this sense, as it is operated on Cape Cod or other points in New England, the winter tourist trade in Florida and California, and resort to beaches on the Jersey coast, to the lakes in Minnesota, to the "dude" ranches of the Rockies—are all examples of this kind of recreational use of land and water areas. It must be recognized that privacy and exclusive use of recreational resources in this way constitute one of the major values sought by the people who have been able to afford time and money for this type of recreation.

On the other hand it must also be recognized that this same privacy may often interfere with the public's fair and proper sharing in the enjoyment of natural wonders and opportunities for recreation, and that cost may prevent a large proportion of our citizens from participating in types of recreation which involve distant areas or contact with fine scenery or historic sites. In these cases the public must control private activities or provide public facilities.

Governmental interference may take the form of preserving scenery along the roadside by controls over private property, prevention of pollution of streams or lakes, game laws, and a great variety of major and minor interferences with private uses of recreation resources to secure their larger use and conservation. Municipalities, States, and the United States also provide publicly owned areas and different kinds of operation of lands for recreational use.

Population Considerations

Trends in the aggregate number, geographic distribution, composition, and occupational and residential status of our population are of significance in determining extent and character of our recreational requirements. As indicated in an earlier section of this report, we are moving forward toward a stationary population at a comparatively early date, with the prospect of some additional millions before reaching that condition.

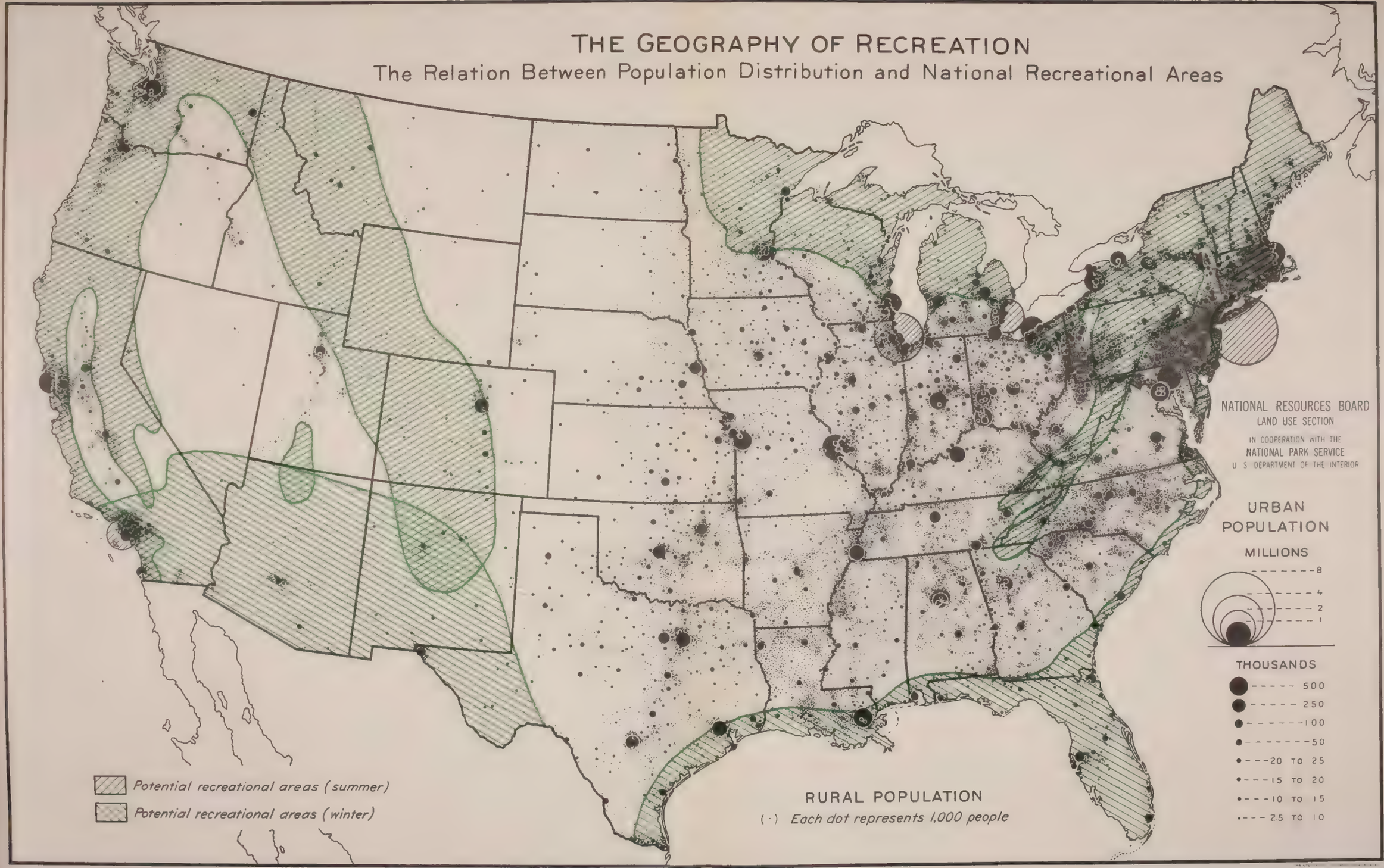
Population is distributed very unevenly throughout the 2,973,776 square miles of the continental United States, as is well illustrated by the fact that the Mountain Division has 3 percent of the population and 28 percent of the total land area, whereas the New England, Middle Atlantic, and East North Central Divisions, comprising only a little more than 13 percent of the total land area, have almost 57 percent of the total population. This fact is of great significance in considering the location of needful recreational facilities for outdoor recreation.

The last census showed that the large cities have increased greatly in population and area but not in population or density within their older sections. Three-fifths of the total population increase occurred in five well-defined groups of cities which had but 26.2 percent of the Nation's population in 1920. The cities in these five groups increased 36.1 percent between 1920 and 1930, compared with a 9 percent increase for the remainder of the United States and 16.9 percent for the metropolitan districts not included in these five groups. Furthermore, over three-fifths of the increase in these five groups of cities is found in two of them, namely the metropolitan districts of the Middle Atlantic Seaboard

[1] The following persons contributed material which has been utilized in the preparation of this chapter: Harlean James, American Civic Association; Niel M. Judd, National Museum; A. B. Cammerer, H. C. Bumpus, A. E. Demaray, H. A. Tolson, H. C. Bryant, G. A. Moskey, T. C. Vint, C. M. Finnan, Isabelle F. Story, W. A. Bloesom, John D. Coffman, and Conrad L. Wirth, National Park Service; George M. Wright, John Nolen, Jr., Herbert Evison, B. H. Thompson, R. W. Toll, L. H. Weir, G. A. Hospidor, R. E. Phillips, R. W. Pierson, J. J. Hengstler, Donald Mc Laughlin, and R. H. Walton of the Recreation Section, National Resources Board.

THE GEOGRAPHY OF RECREATION

The Relation Between Population Distribution and National Recreational Areas



U. S. DEPARTMENT OF AGRICULTURE

NEG. 28084 BUREAU OF AGRICULTURAL ECONOMICS

from New York City to Baltimore by way of Philadelphia, and the metropolitan districts of the Great Lakes region from Buffalo to Milwaukee. The metropolitan portions of these two groups now have about 27,000,000 people concentrated on 11,962 square miles. Three hundred and ten cities in the United States, with a population of 30,000 and over, occupy 4,344,837 acres. A total of 47,395,009 inhabitants, or approximately 38 percent of the total population, is crowded on 0.002 percent of the total land area of the United States. Recreational needs and requirements during the past 70 years, therefore, have been profoundly affected by the tremendous shift from agriculture to industrial, commercial, and professional occupations and the resultant concentrations of population.

Occupational considerations also affect recreational requirements. In 1930 only 21.3 percent of all gainfully employed persons over 12 years of age were engaged in agriculture, lumbering, and fishing. On the other hand, those engaged in manufacturing and mechanical industries rose from 22 percent in 1870 to 26.6 percent in 1930. Trade and transportation rose from 9.1 percent to 29.7 percent; clerical employment from 1.7 percent to 8.2 percent.

In 1890, 18 percent of all children from 10 to 15 years, inclusive, were gainfully employed. In 1930 only 4.7 percent were so employed. Since the new code regulations went into effect in 1933, the employment of this age group has practically been abolished. Inasmuch as school attendance of children and young people occupies only 6 hours a day and yearly attendance 180 days, it behooves the public to provide adequate recreational facilities for them so that their leisure time may be utilized beneficially.

With the continued development of labor-saving devices and scientific management of industry, the proportion of time which our population devotes to gainful employment is likely to decrease materially. There has been a steady decline since 1910 in the percentage of males in all age groups gainfully employed. The decreasing time spent in gainful employment will likely affect more and more the children, young people, and older people of both sexes. Between these two extreme age groups there will be a group of gainfully employed persons working shorter hours.

This situation—fewer persons gainfully employed and shorter hours of work for those who have employment—creates an unprecedented and critical problem which demands farsighted planning for use of the vastly increased amount of leisure at the disposal of the public. This leisure can be made of value in raising the physical, cultural, and spiritual level of the American people if proper provision is made for its use and if it is guided into proper channels. Failure to provide for it properly throws the doors wide open to every antisocial influence, since the truth of the old saying "the devil always finds some work for idle hands to do", is as true now as it ever was.

Geography of Recreation

Recreational resources are located without any relationship to human demands. Variety of elevation—the mountains or water resources of streams, lakes, bays, and ocean; variety of climate—all have an influence on recreational use of land. It is a happy circumstance that 45 percent of the total population, or 55 million persons, live within 55 miles of the sea coast or the Great Lakes. Unfortunately, the great resources of the mountains, particularly in the West, have no such fortunate relationship to location of population. These facts are presented on the accompanying map—Geography of Recreation. A type of recreation which cannot be shown on such a map, however, and which more directly relates itself to population distribution, is the concentration of historic sites in the populous districts of the country. Obviously, archeological and historic sites are an important recreational resource from the larger standpoint of cultural use of leisure time.

Privately Owned Recreation Resources: A few years ago it was estimated that the annual expenditure for recreation amounted to more than 10 billion dollars, all but a small proportion of which was by private individuals and much of it for forms of recreation other than out-of-doors. The recreation business provides a substantial part of the total income in many areas which are especially adapted to the establishment of summer homes, camps, and resorts. This income arises from the commercial undertakings that derive benefits from these establishments and from the people who use them. In Connecticut, for example, the total assessed value of land and buildings devoted to recreational purposes is reported to be over 200 million dollars. It has also been estimated that almost 4 billion dollars was spent in motor camping and vacation travel in the United States in 1929. For the same year it is estimated that hunters and fishermen spent 650 million dollars in addition to their transportation and expenses. In 1931 the total membership of 3,961 private golf clubs was estimated at 800,000 people. The 1929 report of the "Dude" Ranchers Association in Montana and Wyoming shows 51 ranches with property valued at 6¼ million dollars and annual receipts of nearly a million and a half dollars. The normal developments of this private recreation industry obviously is one of the principal elements in the land requirements for recreation in the future.

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Public Control Over Private Recreational Development

This private recreation business and its use of land and water resources necessarily involves regulation and control in the public interest. It has already been pointed out that hunting licenses, prevention of stream pollution, preservation of beauty of roadsides, and similar public activities are essential to the continuing recreational use of many areas, since there seems to be a tendency for private enterprise to "kill the goose that lays the golden egg."

The public is also concerned because many of the recreational opportunities naturally provided by private enterprise are beyond the financial means of the people most in need of them. Municipal, county, State, and Federal recreation activities have had to be provided and must be enormously increased.

Local and Regional Recreation Areas

Municipal Recreation Areas: Because of the present high concentration of the population of the United States in urban communities, the chief burden of year-round recreation service must fall upon the municipal parks. The best utilization of lands and waters within and near the boundaries of cities is therefore highly important.

In 1930, 1,072 cities having a population of 5,000 or more, reported having a total park area of 308,805 acres.[2] The average ratio of the reported park area to population was 1 acre to every 208 persons.

Children's playgrounds and neighborhood parks are the most numerous in municipal recreation systems. However, the greater part of the area (more than 75 percent of the total) is in large parks such as outlying parks or similar reservations. Municipal recreation systems almost invariably show lack of balanced planning. The area devoted to children's playgrounds and neighborhood playfields is often inadequate, and so, too, are the areas devoted to educational-recreational purposes.

The ratio of 1 acre of recreation area to every hundred of the population in cities, has been advocated as a reasonable or minimum standard. On this basis, the cities of the United States having 5,000 population or more have less than half of the desirable minimum acreage of recreation space.

It would be desirable for more cities to have comprehensive and well-balanced plans for the utilization of lands within their borders for recreation. The extension of educational activities will also require more space.

County Recreation Areas: The county is an important governmental agency in metropolitan park planning. The total area of county parks in the United States in 1930 exceeded 100,000 acres. The majority of the 74 counties reporting one or more county parks in 1930, lie in the metropolitan regions of cities. More than half of the total acreage in county parks in the United States is in counties of the metropolitan regions of New York and Chicago.

Recreation services provided in many county parks include those services that are offered in city parks. Other county parks are larger areas kept in a natural condition and with a limited amount of development.

A prominent feature of the larger county park may be the parkway. A parkway is an elongated park, containing a pleasure driveway. Not infrequently a parkway may offer other recreational opportunities, in addition to motoring.

Metropolitan Recreation Areas: A metropolitan district, as defined by the Federal Census Bureau, comprises a central city and all adjacent civil divisions having a density of population of not less than 150 inhabitants per square mile. In 1930 there were 96 metropolitan districts in the United States, each having an aggregate population of 100,000 or more. Contained within are 54 million persons, of whom more than one-fourth live outside the central cities.

The objective of metropolitan park planning is to secure recreational areas that are accessible for frequent use by the people of the district. Metropolitan recreation systems include areas within the central city, and in the smaller cities of the district, but the larger areas are usually located in the more open and less populated parts of the region. With the present use of automobiles, areas within approximately 50 miles of the center of a metropolitan district are accessible for frequent recreational use, even though they lie outside of the district itself. However, there are only 6 special metropolitan park districts in the United States.

It has been suggested that an area equal to that occupied by urban developments should be accessible for public recreational activities within 100 miles of each great city. A rough approximation of needed recreational area on such a basis would come to over 9 million acres, part of which is already available in city, metropolitan, and State parks or reservations.

State and Interstate Possibilities for Outdoor Recreation

The total area of all State parks is 3,701,125 acres, or less than a fourth of the area of the national parks. Because the State parks are readily accessible from large centers of population, however, they are visited annually by a greater number of people than visit the national parks and forests combined.

[2] These figures are misleading because no common definition of park area was used.

Forty-four of the forty-eight States now have State parks or areas set aside primarily or wholly for recreational use. The comparatively low acreage of State parks in many western States is partly compensated by the fact that national parks and national forests offer excellent recreational opportunities for the people of these States. It is estimated that there were 45 million visitors to State parks in 1930.

A few States have made reasonably adequate funds available for the acquisition, development, and maintenance of State parks, but in most States this field of activity is still struggling for adequate recognition. In some States, comprehensive surveys of recreational resources have been made, and a few States have built up excellently balanced systems of State parks. In many cases, however, areas have been included that are too small, of little value for recreation, lacking in scenic quality, or too expensive to operate. While most State recreational areas are called State parks, the parks themselves vary all the way from large important areas to small tracts of little value. In some States a number of camps and picnic grounds have been promoted. The granting of summer-home sites and other exclusive, individual rights has been tried, but such a policy is generally disapproved. A number of State park systems include areas that have historic, prehistoric, or scientific importance, as well as areas of scenic value. Historic sites are usually not suitable for active recreation, and their value should not be impaired by any use that conflicts with their main purpose.

In some States foot trails have been established, usually with the aid of outdoor organizations. These trails are carefully selected strips of land over which the State has acquired a right-of-way for pedestrians. The Appalachian trail, extending along the mountain ranges from Maine to Georgia, more than 2,000 miles in length, is a notable project of this type.

Like the national forests, State forests have important recreational values and they are utilized to varying extent in different States. Some of the State forests offer excellent opportunities for hunting and fishing, as well as camping and a variety of outdoor activities. The State forests are usually larger areas than State parks, and have less density of recreational use.

Federal Activities for Recreation

Several bureaus of the Federal Government are also participating in the provision and operation of recreation facilities. The National Park Service has as its principal function the administration of areas of superlative scenery, or outstanding historic, prehistoric, and scientific importance. The National Forest Service administers 160 million acres of national forests in 33 States, a large part of which has great recreational possibilities which the Service is anxious to make available for public use. The Biological Survey and the Bureau of Fisheries similarly have functions to perform in relation to recreation. The emergency conservation work in the forests and in the State and national parks constitutes another contribution of the Federal Government to this problem of providing recreational facilities.

The National Park Service administers 24 national parks, 1 national historical park, 11 national military parks, 67 national monuments, 10 battlefield sites, 11 national cemeteries, and 4 miscellaneous national memorials, involving in all a total of 15,247,388 acres. National parks proper are almost without exception areas of superlative scenery carved out of the public domain or national forest areas. In these cases, as with historic and archeological monuments established under the Antiquities Act of 1908, the Service is faced with the difficult task of preserving the area and at the same time providing for public enjoyment of the scenery or other features of the park. Additional national parks and monuments have been authorized by Congress in Virginia, Kentucky, Michigan, Florida, and South Dakota. A number of other proposed park areas are recommended by the National Park Service in a later section of this report.

The National Forest Service gives a great deal of attention to the recreational use of the forest land and has specified different types of forest areas for recreation purposes. These include superlative areas, primeval areas, wilderness areas, roadside areas, camp-site areas, residence areas, and outing areas. In addition, they have set aside primitive and recreational places of unusual scenic and scientific quality. The general policy of the Service has been to make available for recreational use other extensive areas not specially devoted to recreation, where such use does not interfere with primary forest purposes; thus, game refuges, forest highways, and similar developments are carried on without interfering with the production of timber or the operation of grazing lands.

Indian reservations are in many cases of great importance from the point of view of scenery and historic interest, but since these lands are set aside primarily for the Indians, general recreational use must, of course, be subordinated to the best interest of the permanent inhabitants.

The public domain also provides a huge area which is available for recreational use, amounting to over 165 million acres, from which special recreational reserves may later be set aside if found desirable.

SECTION II

V. LAND REQUIREMENTS FOR WILDLIFE AND AVAILABLE AREAS*

Need for Specialized Refuges

The importance of establishing more refuges—Federal, State, municipal, and private—as a part of a comprehensive program of wildlife management is becoming more generally recognized, but these must be suitably located and properly administered in order to achieve their highest usefulness. The ideal upland game refuge is a protected area, favoring the rapid increase of game within its borders and from which the surplus may readily spread to suitable surrounding territory that may be open to hunting. It need not necessarily be very large, but alone or in conjunction with neighboring refuge units should provide year-long range, ample forage, water, and cover for resident game. This is the type of refuge that has succeeded so admirably in building up the game supply in the State forests of Pennsylvania and other Eastern States, and on Federal and State refuges in the national forests, mainly in the West.

Wildlife refuges of one kind or another are under the jurisdiction of several Federal Government departments, their varied allocation being largely due to expediency, as the control of wildlife tends to run concurrently with that of the land (or water) it inhabits. (See fig. 34.)

The national parks, under the Interior Department, and refuges in the national forests, under the United States Forest Service of the Department of Agriculture, have already been mentioned. Under the administration of the Biological Survey, of the Department of Agriculture, there are over 100 refuges, mainly for birds, but including a few big-game refuges. These refuges are widely distributed from the interior of the United States and the coastal islands to the Aleutian Archipelago in Alaska, islands of the Hawaiian group, and Puerto Rico. These Federal refuges are administered with special emphasis on the interests of wildlife. The protection of marine mammals, notably the northern fur seal, which breeds on the Pribilof Islands, and the polar bear, is intrusted to the Bureau of Fisheries, Department of Commerce.

Additional refuges of suitable size and distribution should be created for forest game in the forested areas, but are even more urgently needed for restoring mountain sheep, antelope, mule deer, peccaries, sage hens, and other denizens of the more arid parts of the public domain. The unwieldy surplus of deer, antelope, and elk that has already resulted from overprotection in places should not be taken to mean that the protective principle was wrong or that additional refuges would not be desirable, but rather as examples of game mismanagement.

While a sufficient breeding stock of most kinds of upland game, and even of some of the more important fur-bearers, seems within relatively easy reach, the plight of our migratory waterfowl is extremely critical. Human encroachment on nesting areas and overshooting by an ever-increasing army of hunters are mainly responsible for the diminution of waterfowl at a rapidly accelerating rate, and unless these destructive tendencies can be modified, early virtual extermination of one species after another may be expected.

In order to check the depletion of breeding stocks of waterfowl, especially ducks and geese, Federal regulations are annually promulgated under the Migratory Bird Treaty with Canada. State laws and regulations tend to conform with those of the Federal Government; but restrictive regulations alone will not suffice to save the birds. An appraisal of the relative value of many prairie areas before and after drainage brings into relief the vital importance of putting into effect a wildlife restoration program by the Federal and State Governments and all other agencies interested. A system of Federal refuges covering especially the Middle West and the great migration route through the Mississippi Valley is planned, on which the birds may breed unmolested and find feeding and resting grounds. The program for bird refuges is being forwarded by a fund of approximately $6,000,000 made available under the submarginal land program.

At present the major efforts are being concentrated on the first phase of this migratory bird refuge restoration program, but not entirely to the exclusion of the second. The number of acres in a refuge to be so acquired should generally be not less than 10,000 and the maximum acreage in any one unit where the environmental element might be favorable would be 50,000 acres or more. An ideal system of refuges would contemplate a series of major projects approximately 300 miles apart in each one of the four major

* The following people have contributed material which has been utilized in the preparation of this chapter. W. B. Bell, J. N. Darling, and E. A. Goldman, Bureau of Biological Survey; L. S. Gross and C. E. Rachford, Forest Service.

flight lanes and extending from the Canadian border to the southern limits of the United States, and in proximity to most, if not all, of these might well be created groups of refuges that are smaller in size that would be beneficial to the wildlife restoration and conservation program.

Meanwhile, the cooperation of private landowners should be enlisted with a view to restricting, as far as practicable, the grazing of domestic stock and other destructive practices about prairie ponds and in marsh areas of critical importance to breeding waterfowl.

Areas in Public Ownership, or Approved for Acquisition, for Wildlife Refuges

Under the Biological Survey of the United States Department of Agriculture there are wildlife refuges amounting in the aggregate to 828,034 acres. These refuges are located in 27 States and in Alaska. There are also unsurveyed islands near Alaska, Hawaii, and Puerto Rico, the acreage of which is not known. The Biological Survey also administers as wildlife refuges, mostly for birds, 1,206,018 acres in reservoir sites developed by the United States Reclamation Service. This acreage is distributed in 11 western States, and more than half of it is in connection with the Boulder Canyon project in Arizona and Nevada. The Pribilof Islands, Alaska, containing 49,000 acres, are administered by the Bureau of Fisheries, primarily for the conservation and utilization of fur seals.

A total area of 644,582 acres distributed in 15 States and Alaska, now under the administration of the War Department or the Department of Commerce for other primary uses, has been also designated for wildlife refuges. More than five-sixths of the total area is in Alaska.

Within the national forests the net area of game refuges is 25,245,612 acres, of wich 4,002,071 acres are Federal refuges and the remainder State refuges. These are not specialized refuges in the strict sense of the word, as the areas are used for other purposes as well as for wildlife.

Forty-six of the forty-eight States report State game refuges, amounting in all to 44,016,458 acres, and ranging from 7,955 acres in Kansas to 4,461,370 acres in Wyoming. Much the larger part of the total area,

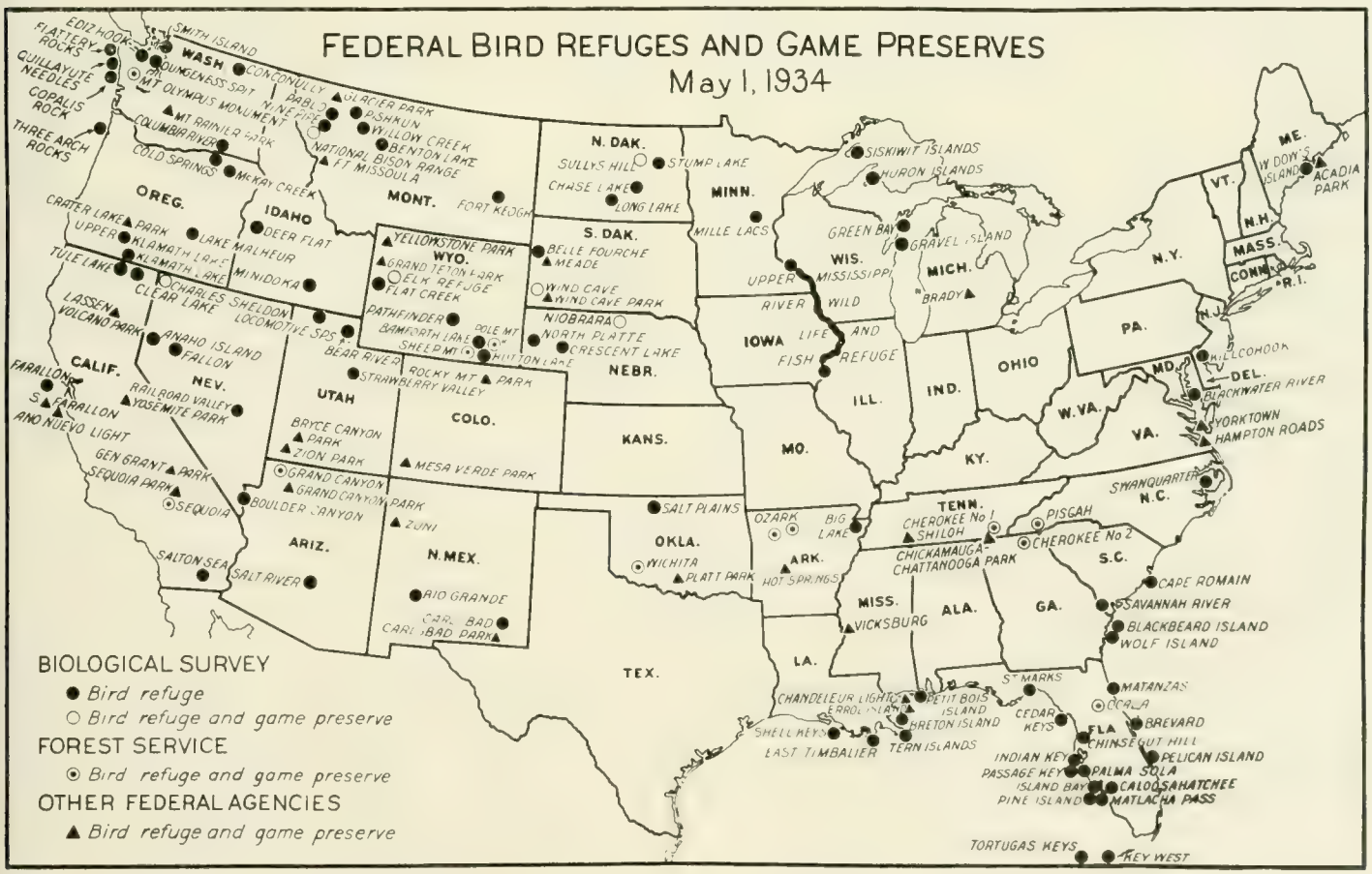

FIGURE 34.—Federal lands now administered as wildlife areas are for the most part bird refuges and big-game preserves under the jurisdiction of the Bureau of Biological Survey, but included in the number are national forests and parks that are also sanctuary areas. The wildlife refuges administered by the Biological Survey numbered 104 on May 1, 1934. Except for the big-game preserves, they are maintained primarily for the protection of migratory game and nongame birds, some of them having been established under the Migratory Bird Conservation Act, which provides for the acquisition of feeding, resting, and breeding grounds for migratory game birds.

however, consists of land devoted to other primary uses. More than three-fourths of the total is in 11 western States, and the greater part of it consists of Federal lands, chiefly in national forests, on which States claim jurisdiction over the game and have established refuge restrictions.

Additional Publicly Owned Areas Needed for Specialized Wildlife Refuges

Additional lands needed for this purpose fall into two main divisions, as follows:

1. Western arid and mountainous areas needed for upland game, especially such big game animals as mountain sheep, antelope, and mule deer, aggregating 21 million acres.

2. Marsh and water areas needed for restoration and conservation of waterfowl, mainly ducks and geese, in accordance with a national plan, aggregating 17 million acres.

Except as a means of perpetuating the remnants of certain almost extinct species of wildlife, as in so-called "primitive areas", experience with wildlife refuges in the national forests has demonstrated the undesirability of permanently dedicating any area or areas as wildlife sanctuaries. The system of management should have sufficient flexibility to permit changes in regulations to keep pace with changing conditions. It should permit the administrative agency to close areas to hunting and fishing and to establish other restrictive measures when and where conditions justify such action. Specialized wildlife refuges in the strict sense of the word should be very few, therefore, but there are large areas of non-commercial forest land and barren land above timber line within the public forests whose major use as far into the future as can be seen will be joint employment for wildlife and recreation.

For the improvement of wildlife administration within the national forests, three classes of additions to the national forests are needed: (1) Completion of the purchase program in the East, within the present purchase units, in order to make possible a better management of wildlife in areas now largely interspersed with private holdings; (2) purchase of certain essential areas of winter game range within and adjacent to the national forests, amounting to 6 million acres; and (3) transfer of certain areas of winter game range within the public domain to adjacent national forests, approximating 14 million acres.

SECTION II

VI. MISCELLANEOUS REQUIREMENTS FOR LAND*

Urban Uses of Land

Urban lands aggregate about 12 million acres, of which 9 million acres are in private ownership and 3 million acres are in public streets, parks, and parkways. It is estimated that urban requirements will increase gradually, reaching about 14 million acres by 1960. Such suburban uses of land as golf courses, cemeteries, etc., now require about 2 million acres, and this area may be increased to 3 million acres 25 years hence.

Highways and Railroad Rights-of-Way

It is estimated that highways and railroad rights-of-way occupy a total of about 23 million acres and that this area is not likely to increase greatly during the next 25 years.

Land Required for Reservoirs

Relatively minor areas of nonurban land are required for such uses as city water supply reservoirs and irrigation and power reservoirs.

Some idea of reservoir requirements for city water supply may be gained from a study of the New York City supply. The three main reservoirs in the Catskill system have a surface area of 18 square miles and an available storage of 177,000 million gallons. The system supplies 600 million gallons daily. This is approximately two-thirds of the entire city supply. It is probable that all the reservoirs furnishing New York City cover a total area of about 24,000 acres. This would indicate that the area involved for the country as a whole is relatively unimportant and needs little consideration in a national land use plan. Since most city reservoir capacity is furnished by existing lakes and river beds and comparatively little additional land is overflowed, there is additional reason for considering this problem relatively unimportant.

Drainage areas reserved for catchment purposes will ordinarily be in forest or grassland and frequently may be suited in some degree to recreational activity.

The situation in the West is somewhat different. Uncertain seasonal supplies, long drought periods, and higher rate of evaporation make larger reservoir capacities desirable.

A large part of the hundreds of millions of dollars being spent for the domestic supply of California cities is used in conducting water a long distance over desert areas and through mountain tunnels.

The irrigation reservoirs of the West have a combined capacity of approximately 25 million acre-feet. This total is less than that which will be supplied by Boulder Dam, which will have a capacity of 30,500,000 acre-feet and a surface area of 145,000 acres.

Boulder Dam will be used for domestic water supply, power, irrigation, and flood control. Many reservoirs in the West serve more than one purpose, and the increasing unit costs of reservoir construction will require that most new reservoirs serve as many economic purposes as possible.

The meager data available at this time on surface areas of reservoirs appear to indicate that probably between 1 and 2 million acres are utilized for all reservoir purposes throughout the country. This does not include the drainage basins, which, as before observed, will normally serve as forest or grazing lands. Even the reservoir itself may be jointly employed as a wildlife refuge. No special consideration need be given to an estimate of drainage areas since these areas will ordinarily be included in forest estimates.

Under suitable restrictions the use of drainage areas or watersheds for domestic and other water supply systems is not incompatible with their use for watershed protection. Under proper restrictions timber production can be practiced with no serious impairment of watershed values. With adequate sanitation facilities, and possibly with more intensive purification systems for the water from the watershed areas, recreational use can be well integrated with the watershed use. It is especially desirable in many cases that these uses should be integrated, inasmuch as forests covering city watersheds are often the best and largest available forest areas accessible to the city population. Agricultural and grazing use of such watersheds is usually possible only under very carefully thought-out plans of management and under rigid restrictions. In general, the restrictions necessary to conduct such uses without endangering the purity of the water supply and the public health are such as to make it impracticable to attempt to integrate these uses. Therefore, wildlife, recreation, and timber production are the only uses for which the watersheds of domestic water supply systems can most logically be employed.

* The following persons have contributed material which has been utilized in the preparation of this chapter: Francis R. Kenney, Land Policy Section, Agricultural Adjustment Administration; and O. E. Baker, Division of Land Economics, Bureau of Agricultural Economics.

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SECTION III

INTRODUCTION—SOME BASIC PRINCIPLES[1]

In keeping with the predominant philosophy of the eighteenth century, the founders of this country were devoted to private property and free individual enterprise. With land as their one great national resource it was but natural that they should turn land rapidly to private ownership. Private property in land meant to them not only individual opportunity, but also the creation of public wealth.

Many of the past and present abuses in land utilization can be traced to the manner in which we disposed of the land. We see now that the granting of farm, forest, and range land under similar or identical methods of distribution was ill designed to serve either public or private interests. Whereas an eighty or a quarter section might be adequate for a farm; a township was necessary to operate a sawmill, and though timber was disposed of by forties, it was cut by thousands of acres. While a section of land was a small fortune in the humid prairies, it proved to be too small an economic unit for either dry farming in certain regions or for range use. Finally, the grants of lands for public improvements, particularly railroads, intermingled with State, private, and Federal lands, remain to this day a handicap to the effective use of range lands of the West.

This is not to imply that a greatly different national land policy could have been adopted. Only details in disposition likely could have been altered in the face of the surging demand to put land into private ownership.

In many respects history has justified this pioneer faith, particularly in the private ownership of agricultural land. It was the motivating force in covering great sections of this continent with productive farms, clearing the forest, and subduing the wild land. However, a corollary to this development was a wide scattering of population at the fringes of settlement, with the attendant hardships of pioneer isolation.

With minor exceptions, the valuable lands of the great public domain have been turned to private hands. Experience, however, has demonstrated the unwisdom of forcing all land into private ownership with virtually no restrictions on mode of use. And as a Nation we have begun gradually to retrace the steps of generous granting of land with the arduous task of public purchase, particularly for forestry and recreation.

It is obvious, since most of our better lands are in private ownership, that a program for adjustments in land use must affect and reckon with the prevailing system of private ownership. The exact nature of the problems involved will be made clearer by an examination of the characteristics of our American system of private property in land.

Our rules of land ownership have been drawn from the antecedent forms of feudal tenure as a part of our legal heritage in the English common law. The decay of feudal tenure was a counterpart of the industrial revolution and the rise of our present economic order. In the process, land as private property became an integral part of the modern business structure.

Under the early system of feudal tenure absolute ownership of the land rested with the crown. By grant of personal privileges, lords held of the king and tenants held of their lords. This holding of land was a personal obligation in the nature of a public office. It was not until the time of Henry II (1154–1189) that the power of the tenant to sell his lands, subject to the payment of certain fines, was definitely established, and the power to dispose of lands by will was not established until long thereafter. But by a long process of change land became freely alienable, an object of purchase and sale within the rules of land transfer. Most of the personal obligations of feudal tenure were transmuted into mere formalities, although land was still "held" of the king.

With the transplantation of the common law to American soil essentially the sovereign state supplanted the sovereignty of the king. The few remaining vestiges of feudal obligations were either discarded or transformed; they could not withstand the impact of free land and the democratic philosophy of government.

While in legal theory the absolute right of property rests in the state, practically the only rights in land retained by the state may be summarized within the three great categories of the power to tax, the power of eminent domain, and the police power. All other rights in the land are privileges of private ownership.

By the police power the state may constrain the private use of land within bounds set by the public interest. The exact limits of these retained rights, however, are subject to constant redefinition according to the social requirements of the time.

[1] Kenneth H. Parsons, Land Policy Section, Agricultural Adjustment Administration, and George S. Wehrwein, University of Wisconsin, have contributed material which has been utilized in the preparation of this chapter.

Intrinsically, property is a system of rights and duties. Excepting the rights retained by the state, privileges to private use of the land are insured by the state through imposing a duty on other persons not to interfere with the owner's free use of the land. Thus there is no property without government.

Rights in the land may be divided in almost unlimited ways. It is obvious that considerations of public welfare may require, at different times, a varying number of rights in land to be vested in the state under the broad powers outlined above. The remainder may be divided among any number of persons at one time. Mineral rights may be owned by one party, grazing rights by another; or a landlord may own land in fee and grant to a tenant the right to cultivate the soil for a term of years.

In general it may be said that private ownership as we know it falls between the two extremes of absolute public and absolute private ownership. While private ownership is not unqualified, nevertheless, under the American system of landed property, owners have virtually the right to use or abuse their land in any way not prohibited by law, and so far as rural land is concerned, restrictions on mode of use have been few.

But private property in land carries within itself certain characteristics which have jeopardized both the private and the public welfare. In order to survive, many private interests are compelled to take a short-time exploitive point of view. In an era of competitive logging and destructive fires, the lumberman who wishes to practice conservative forestry may find his marketss lost to less scrupulous competitors who encounter lower costs. Likewise, the farmer who wishes to adopt a system of farm management designed to eliminate serious erosion may find himself caught in the network of competitive handicaps through increased costs or decreased immediate income. As this report recognizes, public assistance may need to be granted in certain circumstances to enable private operators to eliminate some of these more serious abuses of private ownership without too seriously impairing the value of a property right which they have hitherto been permitted to enjoy without restriction. Changing social conditions require a reconsideration and redefinition of the limits which the state must impose to protect not only the public interest, but also private interests as well.

The recommendations which follow in this report reflect a recognition of the widely accepted principle that private owners should be accorded as free an exercise of the privileges of property as is compatible with the general welfare.

Subsequent sections of the report point out both the details of maladjustment and possible land-use policies to be followed in correction. Some of these policies recognize the right of the state to impose restrictions on the use of private property. In some cases, however, it has appeared desirable to propose assistance to the individual in order to enable him to make certain changes in modes of use that are desirable from the standpoint of general welfare.

SECTION III
I. AGRICULTURAL LAND USE*

The Extent of Desirable Adjustments in Major Land Use Requiring Public Action[1]

In order to outline geographically the areas where different types of major land use adjustments appear necessary, a land-planning consultant was appointed for each State and instructed to outline on maps the areas where certain important adjustments in land use seem desirable in the interest of the common good.

Since it was obviously impossible to undertake a detailed field survey, the consultant was asked to base his judgment on such maps and statistical data as might be available in the State, as well as on certain data supplied from Washington. The consultant also was instructed to obtain an expression of the judgments of various informed individuals within the States, particularly in the agricultural colleges, experiment stations, and agricultural extension services.

Naturally, the different backgrounds of experience of the individuals whose judgments were considered in delineating the land use problem classes in the several States led to widely different points of view and, although attempts were made to avoid abrupt termination of problem classes at State boundaries where no explanation of such changes could be made except in terms of personal judgment, there remained many such instances of different types of adjustment being recommended on opposite sides of State boundaries.

The problems of land use reported arise mainly from three major causes, namely, the uneconomic use of poor farm land for agriculture, the use of agricultural land in such a manner as to facilitate its wastage by erosion, and the lack of productive use of forest land. The adjustments in land use recommended do not include the problem of more efficient management on individual properties in the interest of greater profit, such prob-

[1] The following persons have contributed material which has been utilized in the preparation of this section: C. I. Hendrickson and F. J. Marschner, Division of Land Economics, Bureau of Agricultural Economics; C. P. Barnes, John J. Haggerty, and W. W. Wilcox, Land Policy Section, Agricultural Adjustment Administration; and George T. Renner, National Resources Board.

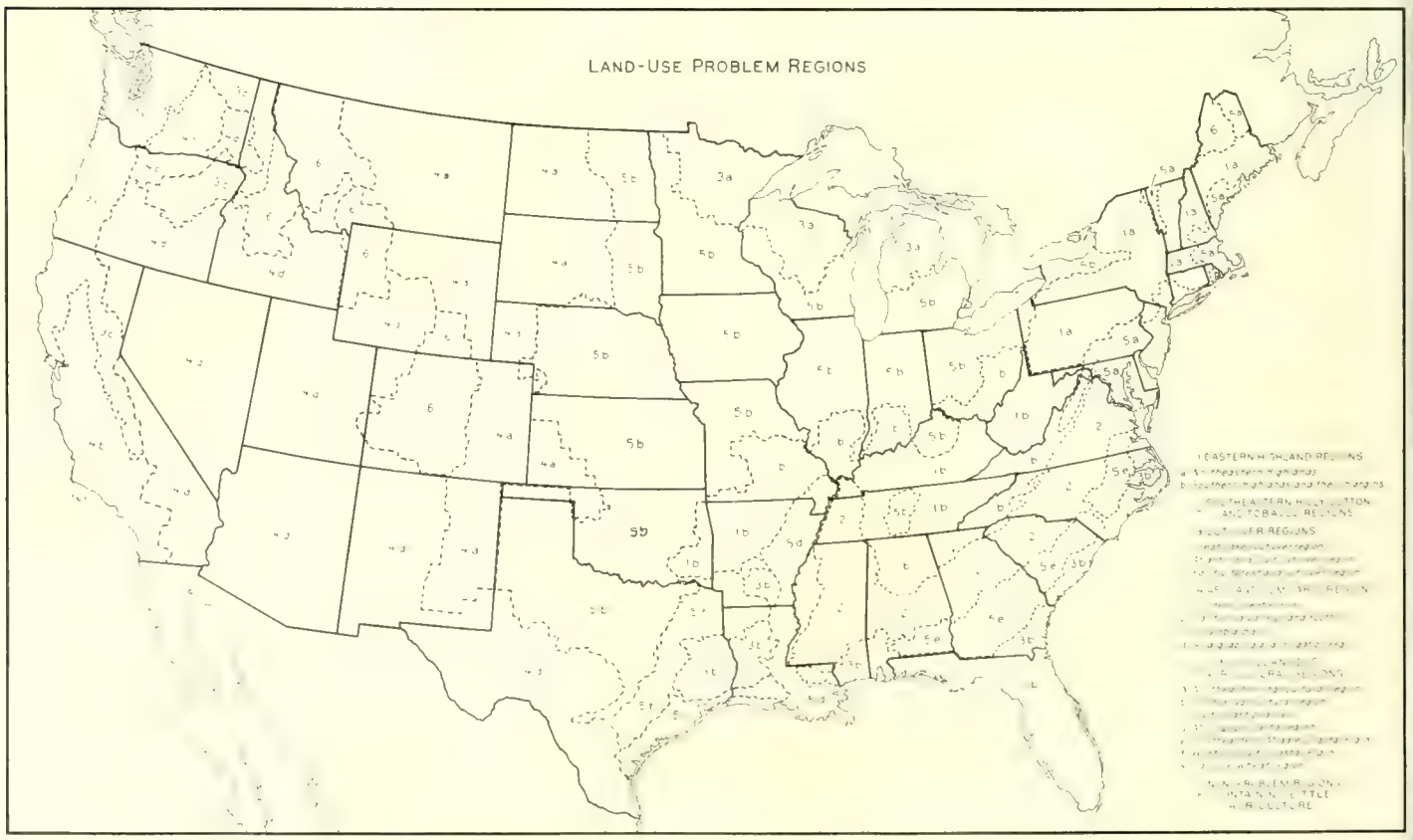


FIGURE 35.—Each of these large regions has a characteristic distribution or pattern of land use problems, which differs in some important respect from that in adjoining regions

lems being considered matters of individual solution. They do include correction of maladjustments in land use leading to collective or community misfortune not readily overcome by individual action.

In delimiting areas needing land use adjustment, some States have been more conservative than others. One of the major adjustments recommended, for example, is the retirement of arable farming from certain poor areas. The desirability of such retirement in any area is contingent upon finding some alternative situation or occupation for the displaced population which will bring about greater well-being than is to be had at present. The apparent difficulties in providing such alternatives at the present time, particularly the lack of outlet through industrial employment, has probably deterred workers in a few States from designating extensive problem areas of this kind. Most States, however, have been very liberal in designating retirement areas, and have advocated a degree of farmland withdrawal which could probably be effected only through a long-time program. (See fig. 44, p. 176.) It is believed to be the intent in most instances to indicate retirement areas as those in which a gradual elimination of agriculture should take place as opportunities arise, rather than in which a rapid large-scale elimination should be effected, although certain areas of acute distress may require wholesale action of an emergency nature

The recommendations for farm retirement range in general from 20 percent to as high as 100 percent of all the farms in the area. The areal extent of the adjustment of this type reported as desirable does not, therefore, indicate the magnitude of the retirement advocated, either in acreage or number of farms. Very extensive areas of sparse settlement may require the elimination of few farms to meet the recommendation, while in smaller, more densely settled areas the recommendation may involve the retirement of a considerable acreage and number of farms. *The maps presented herewith, therefore, do not show the intensity or magnitude of the program in terms of acreage or population but merely the areal distribution of the problem.*

In each of the areas of this kind, it is recommended that measures to prevent agricultural occupation of lands not now in farms and not agriculturally desirable, be instituted. Such measures would involve instituting constructive nonfarm uses of these lands.

In Iowa the purchase of woodland and steep eroding slopes now on farms, and their administration as public forests, is advocated in the interest of conservation. The remaining farm land would continue in agriculture under the plan.

Problems and types of adjustment as reported show a distinctly regional distribution. Certain broad problem regions, each presenting more or less characteristic problems and types of adjustment, are noteworthy (See fig. 35.)

1. *The Eastern Highland Regions:* (*a*) Northeastern highlands (hilly or stony parts of the New England States, New York, Pennsylvania, New Jersey, and Maryland). The major adjustments advocated are wide-spread withdrawal of some of the arable farming, converting the land to some other productive use, and institution of constructive management of forest land.

(*b*) Southern highlands and their margins (highland areas of West Virginia, Virginia, Kentucky, Tennessee, North Carolina, Georgia, Alabama, Arkansas, eastern Oklahoma, Missouri; hilly areas of southern Ohio, southern Indiana; hilly and grassland areas of southern Illinois). Major adjustments advocated are: (1) Wide-spread withdrawal of some of the arable farming in the roughest areas, converting land to constructive use (mainly forest); (2) institution of constructive management of forest land; (3) increasing the size of farm units in the less broken areas, to permit larger acreage of pasture per farm and smaller aggregate areas of crops; (4) introduction of erosion-control measures in the better farming areas.

2. *Southeastern Hilly Cotton and Tobacco Region (Includes also, Tidewater Virginia):* Major adjustments advocated are: (1) Wide-spread, but not general, withdrawal of some of the arable farming, converting land withdrawn to constructive use (mainly forest); (2) introduction of erosion-control measures in the better farming areas; (3) institution of constructive management of forest land; (4) modifications in tenure or financial status of holdings; (5) establishment of larger operating units in the interest of erosion control and adequate farm income (in Alabama and Mississippi).

3. *The Cut-over Regions:* (*a*) Great Lakes cut-over region: Major adjustments advocated are: (1) Instituting constructive management of forest land; (2) wide-spread withdrawal of some of the arable farming, converting land withdrawn to constructive use.

(*b*) Atlantic and Gulf cut-over region: Major adjustments advocated are: (1) Instituting constructive management of forest land; (2) wide-spread withdrawal of some of the arable farming. Some of the States propose little withdrawal of arable farming in this region, indicating that more constructive use of the forest land should furnish additional sources of income for farmers now resident.

(*c*) Pacific forest and cut-over region: Major adjustments advocated are: (1) Wide-spread withdrawal of scattered settlement dependent mainly on arable farming; (2) instituting constructive management of forest land; (3) increasing acreage of improved land on farms by further clearing, and in some locaities increasing size of ownership units.

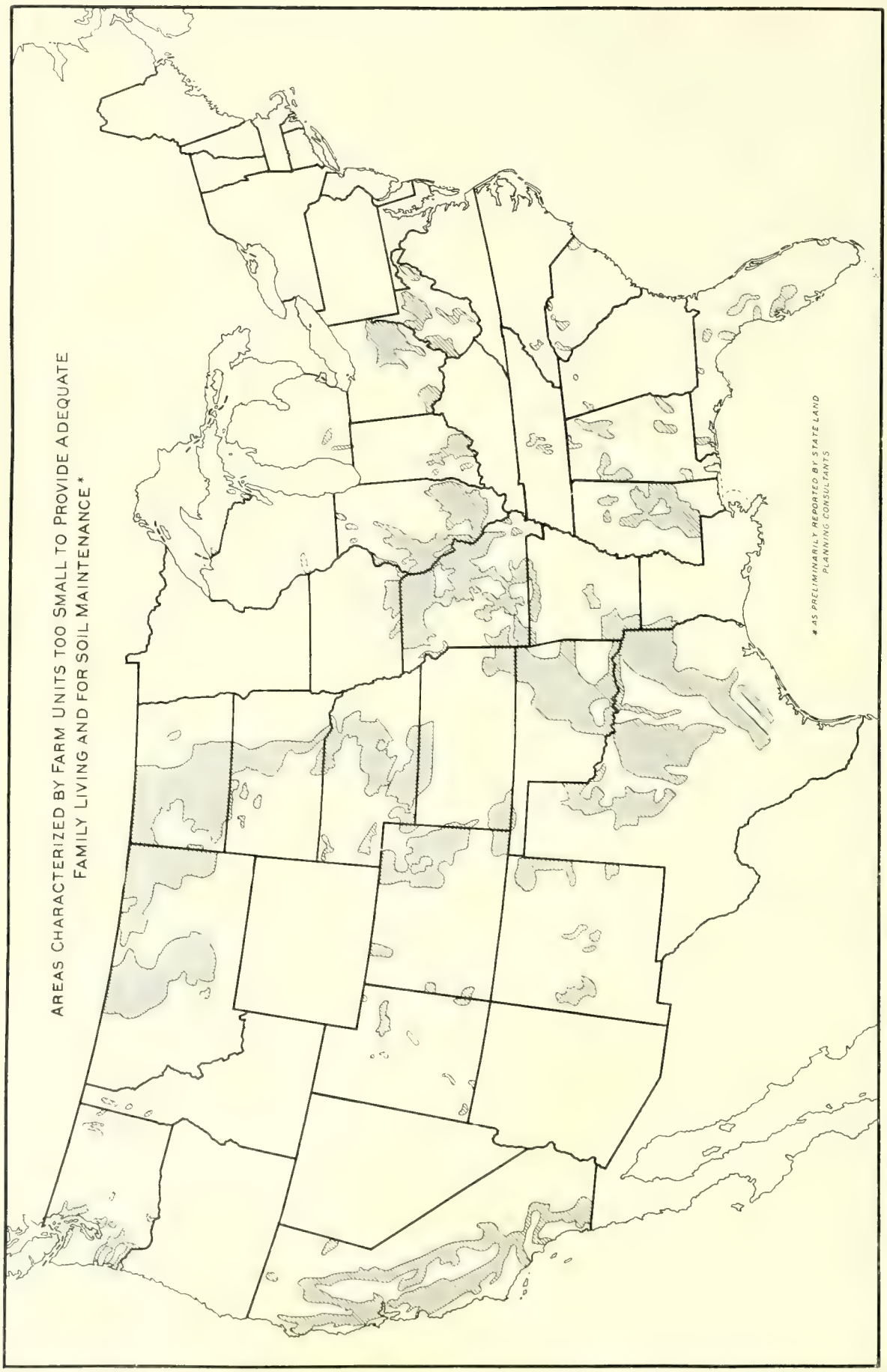

AREAS CHARACTERIZED BY FARM UNITS TOO SMALL TO PROVIDE ADEQUATE FAMILY LIVING AND FOR SOIL MAINTENANCE*
* AS PRELIMINARILY REPORTED BY STATE LAND PLANNING CONSULTANTS

FIGURE 36.—Within these areas many of the farms appear to be too small to provide an adequate family living under the type of farming best suited to the area, and/or to permit the use of sufficient pasture, rotations, or soil-building crops to control erosion and maintain soil fertility. Further investigation will be necessary to determine the extent to which an adjustment toward larger farms is locally desirable.

4. *The Arid and Semiarid Regions:* (*a*) Western Great Plains: Major adjustments advocated are: (1) Wide-spread replacement of grain farming by extensive grazing; (2) increasing the size of farms in areas suited to arable farming so as to provide economic units and permit the extension of pasture.

(*b*) California valleys and foothills: Major adjustments recommended are: (1) Withdrawal of some of the arable farming in the less productive areas, converting the land withdrawn to constructive use; (2) increasing the size of farm units so as to provide economic units and permit the extension of pasture on poor or eroding land, and to permit reduction in crop acreage in irrigated areas subject to progressive diminution of the water supply; (3) institution of measures to control soil erosion on farms needing no increase in size; (4) more judicious use of the range so as to prevent forage depletion, soil erosion, and injury to water supplies; (5) provision of adequate drainage for irrigated farm lands; (6) refinancing of distressed drainage districts; (7) modifications in tenure or financial status of holdings.

(*c*) Columbia Basin: Major adjustments advocated are: (1) Wide-spread withdrawal of grain farming and replacement by extensive grazing; (2) more judicious use of the range so as to prevent forage depletion and soil erosion; (3) refinancing of distressed irrigation districts.

(*d*) Arid grazing and irrigated region: Major adjustments advocated are: (1) More judicious use of the range so as to prevent forage depletion, soil erosion, and injury to water supply; (2) withdrawal of arable farming from scattered dry-farming areas, and from parts of a few irrigated areas, replacing it with extensive grazing and preventing expansion of dry farming; (3) increasing size of units so as to decrease aggregate crop acreage and number of families on irrigation projects with population too great for water supply; (4) refinancing of distressed irrigation districts.

5. *Miscellaneous Agricultural Regions:* (*a*) Northeastern agricultural region: Major adjustments advocated are: (1) Withdrawal of arable farming in small scattered areas; (2) institution of erosion control measures in some of the hillier areas; (3) modifications in tenure and status of holdings in Maryland.

(*b*) Central agricultural region: Problems are confined largely to the southern part of this region. Major adjustments advocated are: (1) Institution of measures to control erosion on farms without necessitating increase in size of farms; (2) increasing size of farms in order to permit the use of erosive land for pasture and reduce the acreage in crops; (3) withdrawal of arable farming in widely scattered small areas, devoting land withdrawn to forest or recreation; (4) refinancing of distressed drainage districts (mainly in Illinois).

(*c*) Gulf coast prairie. Major adjustments advocated are: (1) Provision of additional drainage; (2) introduction of measures to control soil erosion in higher portions. No problems are reported in the Louisiana portion.

(*d*) Mississippi Delta. Major adjustments recommended are: (1) Refinancing of distressed drainage districts; (2) provision of additional drainage; (3) withdrawal of arable farming in sections most subject to flood in Mississippi.

(*e*) Southeastern middle coastal plain (Alabama, Georgia, South Carolina, North Carolina, and Virginia). Major adjustments advocated are: (1) Withdrawal of arable farming from small, scattered areas; (2) modifications in tenure and/or financial status of holdings; (3) institution of constructive management of forest land.

(*f*) Western Gulf coastal plain (Texas, Louisiana, Arkansas). Major adjustments advocated are: (1) Increasing size of farms to obtain economic units and facilitate erosion control; (2) introduction of measures to control erosion on farms, without necessitating increase in size of farms.

(*g*) Palouse wheat region. Major adjustment advocated is institution of measures to control erosion on farms without necessitating increase in size of farms.

Areas Characterized by Farms Too Small to Provide Adequate Living and Soil Maintenance

State land planning consultants report considerable areas suitable for continued agricultural production but in need of a readjustment in size of farm to give farm families enough acreage to make possible a reasonable living and/or to permit a less intensive use of the land where erosion is a serious problem. The geographic distribution of this problem is indicated by the accompanying map (fig. 36), and the areas may be grouped under six headings.

The Wheat Producing Region of the Great Plains States: Both the laws governing the homesteading of this region and the previous experience of the new settlers who came from the humid regions caused farming operations to be attempted in parts of these States on farms which are too small. The low production per acre and the frequency of droughts make it necessary to farm an extensive acreage and carry reserves, or a large proportion of the population periodically have to obtain funds from outside sources. This problem is reported as serious over an area of approximately 32 million acres of farm land, farmed by 46,000

families. Larger farms in this area would permit more extensive use of summer fallowing and the return of the poorer crop land to range pasture. Tentative estimates of adjustments desirable in this area in the interests of a more stable agriculture indicate a retirement of perhaps 1 to 1½ million acres of crop land. Because of the increased proportion of the crop land left in summer fallow the reduction in wheat acreage might well be about the same amount with a reduction of feed grains of ½ to 1 million acres. Around 16,000 families would be displaced in increasing these farms to a size adapted to the farming conditions.

The Erosive Areas of the Southern and Western Corn Belt: Competition with farmers on better land has led to overcropping the erosive lands along the eastern edge of the sand hills, the dissected plains of southern Nebraska and northern Kansas, and the hilly areas of southern Iowa, northern Missouri, and western Illinois. A continuation of overcropping on these erosive lands will progressively lower their productive capacity. This problem has been reported as serious for an area covering about 36 million acres of farm land, including 20 million acres of crop land, now divided into 188,000 farms. The seriousness of the problem, the extent to which crop land should be retired to permanent pasture, the extent to which decreased cropping can be offset by more intensive livestock production, such as poultry raising, and the extent to which the farm acreage should be enlarged are not fully known. Tentative estimates place the desirable reduction at around 1 million acres of corn and perhaps 225,000 acres of wheat, with a total reduction of around 2 million acres of crop land. Such adjustments would mean that approximately 19,000 families would be displaced and would have to find better opportunities elsewhere.

General Farming Regions of the Ohio Valley, Southern Illinois, and Southern Missouri: State representatives report a serious problem in parts of these regions where the soil is too infertile to yield reasonable returns for the effort spent in raising crops. Larger farms with a higher proportion of the land in hay and grass would make possible a more adequate living on the more level lands and in addition would prevent continued erosion on the rolling lands. This problem has been reported as serious covering an area of 21 million acres of farm land, including 8 million acres of crop land, now divided into 195,000 farms. Tentative estimates indicate the desirability of retiring about 2,400,000 acres of crop land to pasture, including about 500,000 acres of corn and 75,000 acres of wheat. Adjustments of this magnitude would displace around 48,000 farm families. Because of the lack of opportunity for resettlement nearby and the difficulty of adjustments for these people in other regions, this desirable reorganization of farming units may have to await industrial development sufficient to employ the surplus population.

The Cotton Belt: From central Texas east to South Carolina, areas were reported where erosive land was being farmed too intensively. These areas are characterized, however, by having much arable land not in farming units and considerable idle crop land. Presumably, therefore, this situation can be remedied to a large extent by a readjustment of the population within the region without necessarily making a net change in cotton production or population for the region. It should result in a larger acreage of forage crops grown both for the prevention of erosion and for livestock feed. Although only 50 million acres of farm land are included in the areas reported, there are 417,000 farm families.

Irrigated Areas: Inadequate water supplies and too great a subdivision of land on several irrigation projects has given rise to the problem of farms too small to make possible a reasonable living. Progressive lowering of the water table, in some instances where pumped water is used for irrigation, points to future difficulties, although evidence of economic distress among the farm population is not yet apparent in all cases. Probably not over 20,000 families or 2 million acres of farm land are affected, and the solution of the problem will vary with each irrigation project.

Miscellaneous Areas: In addition to these large areas where the problem of farms of inadequate size has been reported as serious, smaller miscellaneous areas have been reported in the cut-over areas of the Pacific Northwest, where the problem is largely one of clearing more land on present farms, in Michigan, and in other widely scattered places.

Our present experience indicates that both the State and Federal Governments have an interest in the use of these national resources and the families dependent on their use for a living where the income derived therefrom is becoming progressively less or is extremely hazardous. Drought-relief and other rural-relief loans must be attacked at the source of their trouble.

Policies for Facilitating this Type of Adjustment in the Above-Mentioned Areas: A general adjustment toward larger farms in a given area cannot easily be effected by individual action. The acquisition of adjoining operating units so as to bring about farms of most desirable size in an orderly manner requires collective or cooperative action.

The Federal Department of Agriculture, in cooperation with the State experiment stations, should work out a more accurate definition of the areas where this type of adjustment is required, and the size and types of farming necessary to a system of permanent agriculture capable of furnishing a reasonably adequate livelihood for the families involved. In conjunction

with the Farm Credit Administration, steps should be taken to effect the necessary adjustments in indebtedness to make possible the requisite changes in tenure either by purchase or lease. The program should be closely coordinated with the program for retiring sub-marginal land and for the resettlement of the redundant population.

Farm Lands Subject to Soil Depletion from Erosion or Other Causes *

Conservative use of land resources rests upon compliance with the principles of a safe land use as disclosed in the physical factors of control; and its accomplishment is conditioned on a number of considerations. Economic forces alone cannot be relied on to effect conservative use of land. Policies and measures for the general welfare of local, State, or Federal Government interests may be required to supplement and/or guide economic factors in preserving the soil and its benefits for this and future generations.

The Approaching Erosion Crisis: The approaching physical crisis in land use within the United States is a consequence of the period of exploitation in the rapid occupation of the American continent by the American people. The time when worn-out land can be abandoned for virgin soils lying to the west, with their stored fertility, is gone. Practically all the better lands of the country have now been occupied for agriculture. The westward movement of the old agricultural frontier has reached the Pacific; the new frontier is appearing under foot on the farms now under cultivation. Conservation of soil and water resources and intelligent soil and farm management now constitute fundamental problems of land use.

It is estimated, on the basis of reconnaissance erosion and available soil surveys, that already the utility of approximately 35 million acres of formerly good farm land has been essentially destroyed, insofar as the production of cultivated crops is concerned, chiefly by gully erosion. This represents an area about the size of Pennsylvania, Massachusetts, and Connecticut combined, or 218,000 farms of 160 acres each. From about 125 million additional acres—land still largely in cultivation—the topsoil, representing the most productive part of the land, has been washed off or largely washed off by the erosive action of unrestrained run-off of storm waters. In addition, approximately 100 million acres of cultivated land are starting in the direction of the 125 million acres of impoverished soil-stripped land. These prodigious losses do not take into account the wide-spread erosional wastage that is speeding up over the vast domain of the western grazing areas.

This wastage of the most basic and indispensable resource of the country—the soil—has become one of the most important problems confronting the Nation. From a country with a large proportional area of rich agricultural land we are plunging, almost heedlessly, in the direction of a nation of predominantly poor agricultural land, as the result of unrestrained erosion.

The economic and social aspects of this tragic transformation have been tremendous. The acceleration of erosion in the East and in the South, in the North, and in the West, has reached an enormous annual cost to the Nation, as measured by soil depreciation and reduced yields alone; and has carried with it consequences of first importance to the permanence of investments in the billions of dollars in navigation, water-power sites, municipal water-supply reservoirs, irrigation developments, agriculture, and grazing. Accelerated erosion has combined with and speeded up run-off of surface water from bared slopes to accentuate flood peaks and to augment the cutting power of stream flow. Equally significant has been the transformation of fertile soils into troublesome sediments. Products of surface-soil wash (sheet erosion) and gully excavation have been carried by storm flows to be deposited in stream channels and in existing reservoirs. Shoaling of streams and rivers has followed large-scale erosion of upland soils. Particularly significant and important is the rapid rate of silting which is going on in reservoirs located on streams within critically eroding areas of the country, in the East as well as in the West. The products of erosion deposition have built numerous areas of valuable alluvial land generally safe from erosion. These areas, however, are being damaged in many places by overwash of infertile sand and gravel and poor subsoil material washed out of eroding uplands.

Physical Bases and Risks in Agricultural Production: While soil erosion constitutes one of the major problems confronting American agriculture, it cannot be considered apart from other factors involved with land productivity. The physical basis of production includes (1) climate, (2) topography, (3) soil fertility, and (4) the character of the soil profile. Production of crops is therefore conditioned by the attendant risks of (1) climatic shifts, which in their major influences are beyond human control; (2) fertility risks, which lie within the limits of partial control; and (3) soil-wastage risks, which are almost completely within the power of human control.

* The following persons have contributed material which has been utilized in the preparation of this section: H. H. Bennett, W. E. Beamon, T. H. Benton, Lyman D. Carrier, Henry M. Eakin, Glenn L. Fuller, W. C. Lowdermilk, C. B. Manifold, and Max D. White, Soil Erosion Service; Jacob G. Lipman, New Jersey Agricultural Experiment Station; C. I. Hendrickson, Division of Land Economics, Bureau of Agricultural Economics; Charles Gooze, J. J. Haggerty, and W. W. Wilcox, Land Policy Section, Agricultural Adjustment Administration; Mark Baldwin, Bureau of Chemistry and Soils; and E. W. Lehman, Bureau of Agricultural Engineering. The State agricultural experiment stations assisted in the soil-erosion reconnaissance survey.

Climatic Risks: The great drought of 1934 tragically demonstrated that climate is not a fixed quantity, but that climatic borders shift back and forth over wide zones. Between the humid region and the desert is a zone wherein agriculture is profitable, unprofitable, or entirely a failure, as influenced by the shifts of the humid and arid climatic limits. Such seasonal and periodic shifts affect the prevailing agricultural pursuits from cultivated crops to range lands. Frequency and extent of crop failures in response to shifts of adverse dry or cold climatic limits will determine the safe cultural and other agricultural measures within the areas affected. Extensive areas of the Great Plains, for example, must be classed as unsuited to sustained cultivated crops, and should therefore never have been plowed, but retained in grass for stock raising. A thorough inquiry into the climatic risks and limits for different types of agriculture is emphatically called for.

Fertility Risks: The soils of the United States possess vast reserves of plant nutrients. Additions to and losses from these reserves are taking place constantly. Tables 12 and 13 and figure 37 offer in condensed form information relative to the reserves of nitrogen, phosphorus, potassium, calcium, magnesium, sulphur, and organic matter, the annual additions thereto, and losses therefrom, for 1,365 million acres of continental United States. The additions to the inventory are to be credited to atmospheric precipitation, crop residues, grasslands, forests, green manures, animal manures, lime and marl, commercial fertilizers, sewage, irrigation water, peat, and industrial by-products. The losses are chargeable against removal by crops and animals, burning, erosion, and leaching. These calculations are based on soil analyses and lysimeter studies applied to 365 million acres in harvested crops and 1 billion acres of pasture of all kinds. It is shown here that the surface soil (6⅔ inches) contains 12 billion tons each of calcium and potassium; 1,700 million tons of nitrogen equivalent; 800 million tons of sulphur; and the estimated equivalent of 34 billion tons of

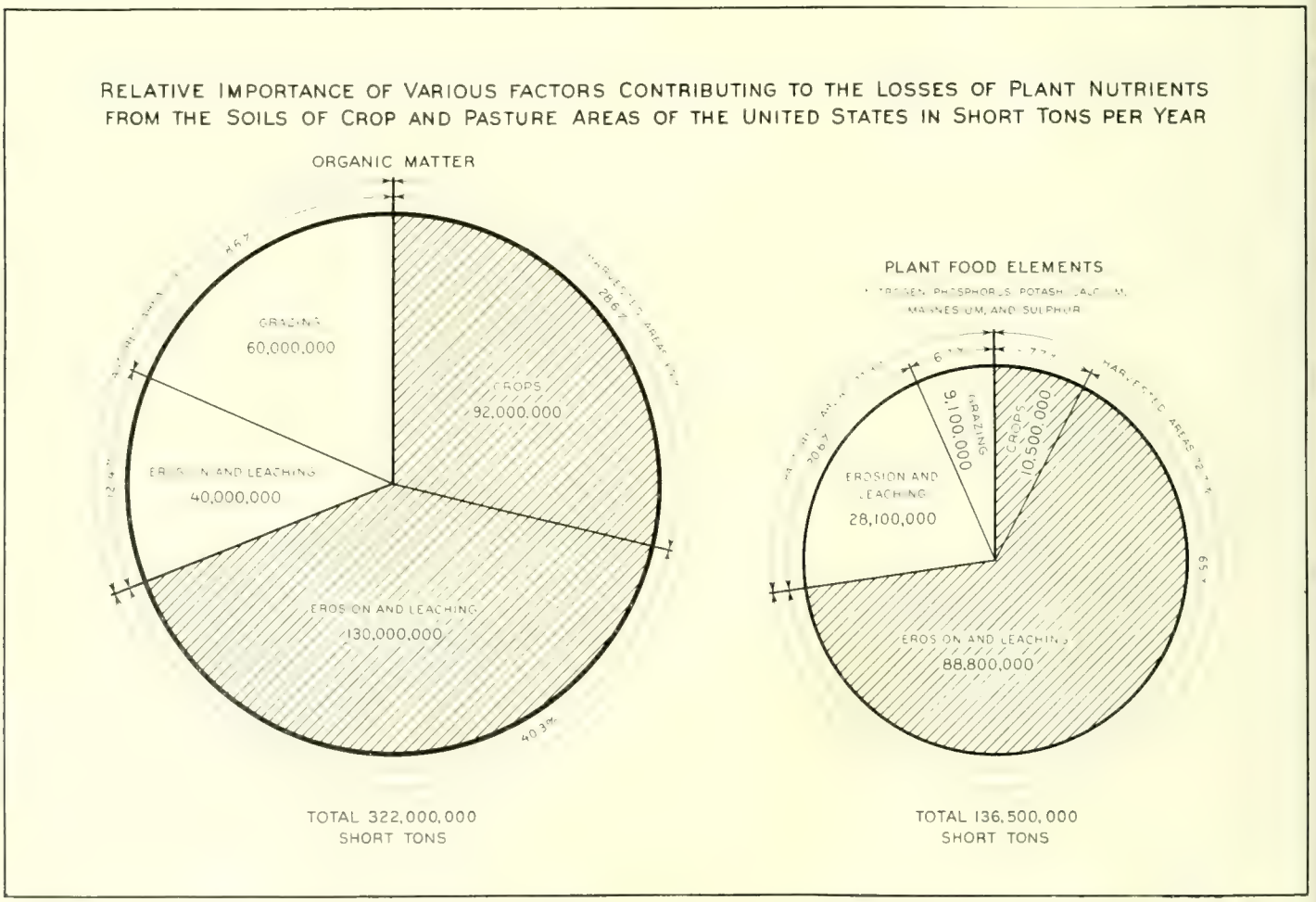


FIGURE 37.—Losses of organic matter, shown in the larger pie chart, are chiefly from crop land. Of the total losses 68.9 percent is from the harvested areas, of which 28.6 percent is removed by crops and 40.3 percent by leaching and erosion. Of the 31 percent of the total organic matter which is lost from pastured areas, 18.6 percent is removed by grazing and 12.3 percent by leaching and erosion. Losses of nitrogen and mineral salts, shown in the smaller pie chart, also are greater on cropped than on pastured areas. Of the total losses of these plant nutrients, 72.7 percent is lost from harvested areas. Leaching and erosion are responsible for 65 percent of these losses and cropping for 7.7 percent. Of the 27.3 percent lost from pastured areas, 20.6 percent is lost through leaching and erosion and 6.7 percent is removed by grazing.

organic matter. No data are recorded here for manganese, iodine, copper, fluorine, boron, zinc, and 2 or 3 other elements significant for plant growth but present in the soil in relatively minute quantities.

TABLE 12.—*Plant nutrients annually lost from soils of the United States* [1]

[Thousands of tons]

Losses	N	P	K	Ca	Mg	S	Organic matter
Crop, harvested areas	4,600	700	3,200	1,000	500	500	92,000
Grazing, pastures	3,000	500	3,700	1,000	500	400	60,000
Erosion and leaching, harvested areas	6,500	900	21,600	39,600	12,000	8,200	130,000
Erosion and leaching, pastures	2,000	400	7,700	12,000	3,800	2,200	40,000
Total	16,100	2,500	36,200	53,600	16,800	11,300	322,000

[1] Area considered: Harvested crops, 365 million acres; pastures and woodland grazing areas, 1,000 million acres.

TABLE 13.—*Plant nutrients annually added to soils of the United States* [1]

[Thousands of tons]

Additions	N	P	K	Ca	Mg	S	Organic matter
Resources of 6⅔ inches topsoil	1,700,000	800,000	12,000,000	12,000,000	5,500,000	450,000	34,000,000
Fertilizers and liming materials	300	300	300	2,100	(2)	700	(2)
Manures	2,600	800	2,000	1,200	600	300	100,000
Rainfall (1,365 million acres)	1,200		2,000	7,500	3,000	5,500	(4)
Irrigation (20 million acres)	30		500	3,000	1,000	2,200	(4)
N fixation by legumes	900						
N fixation in other ways	6,800						
Total additions	11,830	1,100	4,800	13,800	4,600	8,700	100,000
Net losses	4,270	1,400	31,400	39,800	12,200	2,600	222,000

[1] Area considered. 365 million acres harvested and 1,000 million acres pasture and woodland pasture.

[2] Included with Ca. [3] Small amounts. [4] Not determined.

Notice should be taken of the ratios which the annual additions and net losses of the several nutrients bear to the soil inventory. It will be noted that the balance sheet shows a net annual loss of considerable proportions of each of the essential plant food elements. Parts of these terrific losses are preventable. They are compensated for in some measure by the exposure of fresh substratum material to weathering. Where the removal of the surface soil by erosion proceeds very gradually, as under undisturbed conditions, this compensating factor is of importance. On those areas where surface removal has been seriously accelerated through the instrumentality of man and his domestic animals the compensating factors fail to protect the farmer against declining soil productivity and resultant declining crop yields. Over large areas soil depletion has progressed to a point where the land is no longer economically valuable for agricultural use.

Table 14 presents the results of analyses of the contents of dissolved material in the major rivers of the United States. Considerable proportions of the more active elements, such as nitrogen, phosphorous, and sulphur, are utilized by various forms of organic life somewhere between the point of origin and the sea; while much of the less active elements, such as calcium and magnesium, are deposited in comparatively insoluble form in the substrata and elsewhere.

TABLE 14.—*Summary of plant nutrients annually carried to tidewater by American rivers (dissolved material only)*

River basins	Area of river basins	Total	Quantities of plant nutrients carried in solution			
		N	K	Ca	Mg	S
	Acres	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
Mississippi	809,600,000	183,878	2,438,374	18,111,633	5,636,269	7,825,154
North Atlantic	101,696,000	53,259	178,549	2,593,852	560,461	839,305
South Atlantic	79,315,000	21,887	273,297	1,085,637	252,002	245,149
Gulf of Mexico	231,565,000	44,039	912,953	7,945,251	1,512,703	2,527,878
Pacific coast	366,528,000	192,856	825,339	4,946,162	1,438,177	2,434,325
Hudson Bay tributaries	39,680,000	1,819	22,058	328,048	131,785	52,601
St. Lawrence	112,000,000	50,214	502,140	5,188,780	1,205,136	669,520
Great Basin	142,720,000	(1)	(2)	(3)		
Total United States	1,883,104,000	547,952	5,152,710	40,199,363	10,736,533	14,593,932

[1] Denudation [2] Considered. [3] Zero.

Depreciated soil productivity, as distinguished from fertility losses, cannot be fully measured solely on the basis of content of plant nutrients revealed by chemical analysis, for the reason that it is not easy to differentiate accurately between available and nonavailable nutrients. Freshly exposed clay subsoil may show on analysis a higher content of plant food than that of the topsoil, and yet produce very much less with the same cultural treatment. This means either that the subsoil contains less available plant food or that the plant roots are unable to assimilate the contained plant food because of the unfavorable physical character of the erosion-exposed clay. These continuing losses from the soil indicate the necessity for a positive program of soil conservation, and for the development on the part of landholders and the public generally of a sense of social responsibility for the soil resources intrusted to their care.

Soil Wastage Risks: The risks of soil wastage by erosion are comprehended only through an understanding of the nature of soil-forming processes and soil

development, and of the measures of maintenance and reclamation required to preserve or restore productivity. Soil erosion decreases the inherent productivity of soils and eroded material may cause infertile overwash upon lower slopes and alluvial plains and deposition of water-transported material in stream channels and reservoirs. The hazards of soil erosion are dependent on such factors as:

1. Climate: Involving, particularly, mean, maximum, and minimum temperatures; and amount, distribution, and intensity of rainfall.
2. Erosivity of soils as reflected in profile, textural, structural, and consistency characteristics.
3. Slope gradients.
4. Methods of use.

Virgin soils represent a resource which has been thousands of years in the making. The accumulation of the soil material, except in flood plains, and its subjection to long-continued soil-development processes have been possible on sloping areas (about 80 percent of the surface of the Nation is sloping), especially through the protectve influence of the natural cover of vegetation. On the other hand, the climax type or association of vegetation is dependent on the accumulation of soil. Thus, over long periods of time, there has been built up a dependent relation between soil and vegetation. Accordingly, the soil profile represents the response to a number of important chemical, biological, and physical processes. For example, the Marshall silt loam series of Missouri during the past 1,000 years has been subjected to the percolation of water equivalent to a column fully 1,700 feet high.

Conservation of a product of this character, which is basic to the storage of precipitation waters—a great natural resource representing a laboratory which produces, stores, and expends plant nutrients—must be given the most serious consideration by the Government; for, once it is lost, there is no possibility of recovery for centuries to come. Cultivation of soils for necessary crops interrupts many of the processes in soil development. Plant nutrients extracted in crops may be returned in the form of fertilizers, organic

FIGURE 48.—Excessive sheet erosion. Palouse silt loam on farm land near Moscow, Idaho. About 50 tons of soil per acre were lost during the winter of 1933-34 from this newly fall-seeded wheat field following summer fallow.

FIGURE 39.—The death stage of land. Formerly a productive piedmont farm in the South Tyger River watershed, South Carolina. Due to lack of knowledge of proper control measures, the topsoil was stripped off, then the exposed subsoil ripped by gullies. This is part of 10,000 acres in similar condition within the neighborhood.

materials, and crops plowed under to replenish the humus supply; but the physical body of the soil itself, once it has been swept into the stream channels and oceans, cannot be restored to eroded slopes. Even that which has been moved only so far as from the upper to the lower side of a field cannot be hauled back economically for the simple reason that a cubic yard of soil weighs more than a ton.

Soils are subject to conservative management, and in the interest of national economy the manner of their use, particularly the manner of their preservation, requires national recognition and action.

The Process of Soil Erosion: When the bared surface of a soil, hitherto protected by a mantle of vegetation (whether forest, brush, or grass), is exposed to the full impact of rain and wind, erosional processes of a different order are set in motion. They proceed at a greatly accelerated rate over the slow surface planation that went on under natural conditions. Quantitative measurements and careful research have disclosed the rates of run-off and erosion, as well as some of the fundamental processes involved, under both natural and disturbed ground conditions.

The following table gives the comparative amount of erosion and the percent of the total precipitation lost as run-off from 12 widely separated, extensive, and important types of soil.

Types of Water Erosion: Accelerated soil erosion may be classified into:

TABLE 15.—*Comparison of erosion and run-off from 12 widely separated important soil types*

Soil and location	Slope	Clean-tilled crop		Thick crop		Averages for periods covered by data[2]
		Soil loss	Water loss	Soil loss	Water loss	
		Tons per acre	*Percent precipitation*	*Tons per acre*	*Percent precipitation*	
Shelby silt loam, Bethany, Mo.	18	[1]60.8	[1]27.4	[1]0.3	[1]7.7	1931–33.
Shelby loam, Columbia, Mo.	3.7	19.7	30.3	.3	12.5	1918–31.
Colby silty clay loam, Hays, Kans.	5	13.2	17.5	.004	.04	1930–33.
Kirvin fine sandy loam, Tyler, Tex.	8.8	19.1	20	.2	1.5	1931–33.
Nacogdoches fine sandy loam, Tyler, Tex.	10	6.1	15.4	.02	1.4	July 1931–33.
Vernon fine sandy loam, Guthrie, Okla.	7.7	28.1	14.2	.04	1.5	1930–33.
Marshall silt loam, Clarinda, Iowa.	9.6	44.6	12.5	1.3	6.5	June 1932–33.
Clinton silt loam, La Crosse, Wis.	16	59.9	19.2	.003	2.9	1933.
Abiline clay loam, Spur, Tex.	2	6.1	12.8	1.6	5.8	1926–33.
Houston black clay, Temple, Tex.	4	12	11.6	.00	.00	1931–33.
Cecil clay loam, Statesville, N. C.	10	13.8	9.3	7	5.5	1931–33.
Palouse silt loam, Pullman, Wash.	30	31.2	[1]29.8	.4	.3	July 1931–33.

[1] Hard fallow (no continuous clean-tilled crop).

[2] Average results show grass approximately 65 times more effective with respect to soil conservation than a clean-tilled crop on same kind of soil having the same slope; and approximately 5 times more effective with respect to conservation of water.

1. Sheet Erosion: Sheet erosion relates to the slow process of removing a thin sheet of soil more or less evenly from a sloping area. It usually proceeds without being noticed by farmers, at least not until the evidence is called to their attention. Sheet erosion is a thief that stealthily robs the farmer of this principal capital—that is, his rich topsoil.

2. Gully Erosion: Gullies develop on erosion slopes, usually in depressions, as the result of rapid collection of surface water into streamlets having strong cutting and transporting power.

On steep slopes and more vulnerable soils these wet-weather waterways (gullies) form and spread rapidly if neglected, cut into the soil and then into the subsoil like ripsaws. When a gully cuts through the upper soil layers into loose, soft substrata (as sand, silt, or decomposed rock), ravines of spectacular proportions are rapidly formed. Such rapidly formed gullies (gullies of the under-cutting, caving type) are common in the piedmont region, the loessial soil areas, and the alluvial valley fills of the West.

Gully erosion rapidly develops to a stage which renders the land permanently unsuited to cultivation. Between 25 and 30 millions of acres of formerly good farm land in the United States has been essentially ruined in this manner for any future use as crop land. Its only use is for rough pasture or forests.

Wind Erosion: Until recently, destructive movement of soil by wind has largely been associated with areas of deep sands, as dunes, and the western deserts and bad lands of the arid regions. Within the past few years the problem of wind erosion has become increasingly grave. In some regions it has become so destructive that the public has demanded that the problem be recognized and control measures undertaken.

Under normal conditions of ground cover and stability wind erosion, like water erosion, proceeds slowly. With the advent of cultivation and grazing the action of wind erosion was accelerated far above the rates which obtained under undisturbed conditions, particularly in treeless regions. At first it was local and infrequent, with duststorms and whirlwinds that were annoying but not generally destructive. As cultivation became more extensive and intensive, the surface soil lost its resistance to the frequent strong winds, and steadily the process was accelerated. Destructive wind erosion, accordingly, became a serious problem in various critical regions.

The principal wind-erosion areas lie within the semi-arid regions of the Great Plains, both north and south, where the annual rainfall is less than 25 inches. There are other important affected areas, however, in many parts of the West. Many of these declining lands occur within extensive agricultural sections.

An essential difference between wind erosion and water erosion is that the latter is operative only on sloping ground, while the former affects land of any topographic character, whether level or steeply sloping.

Damage by wind erosion is wide-spread; it is evidenced not only by impoverishment of land through stripping and covering but also by obstructive accumulations in fields, along fences, highways, and railroads; and by filling of ditches and covering of farm machinery and buildings. Also considerable damage is caused through the cutting off of young grain by the abrading sand, and by covering of pasture grasses to be followed by weedy vegetation. Fine material sifting into dwellings and shops damages the furnishings and other contents. General discomfort and menace to the health of the population are among other undesirable features of all wind-eroding areas.

Some of the more effective control measures are: Strip cropping, "listing" (plowing the soil in rows), selective retirement of the more erosive areas from clean cultivation and seeding them to soil-holding vegetation, cultivating so that not all crop residues are covered, cloddy plowing, crop rotation, and level terracing to trap the rainwater. The Soil Erosion service has in operation now a demonstrational project for wind-erosion control in a severely affected section of the Texas Panhandle, where all of the above measures and others are being applied to the land in accordance with the needs and adaptability of the different kinds of soil and topographic features.

Factors Affecting the Rate of Accelerated Erosion: Since the character and condition of the soil and its cover determine the rate of percolation, the rates of surface run-off may vary widely under the same rainfall intensities. Results of experimental studies of factors affecting rate of run-off are shown in figures 40, 41, and 42.

Consequences of accelerated erosion:

1. Sedimentation: In both South and West rapid silting of reservoirs is in force. Complete filling of many reservoirs and reduction of storage capacity of others have already made serious inroads upon developed water-powers of the southern industrial region and irrigation projects of the West. Of the 56 reservoirs studied by the Soil Erosion Service in the southern agriculture piedmont region in 1934, 13 major reservoirs with dams averaging 29.8 feet in height were found completely filled with products of erosion within an average period of 29.4 years. In the West significant instances of complete filling of reservoirs include the Austin Dam at Austin, Tex., nearly filled in 5 years and completely filled in 15, and the Harding Reservoir near Santa Anna, Calif., filled almost entirely during a single month of heavy rains following a burn in its

(Continued on page 169)

TABLE 16.—*Silting of reservoirs*

Reservoir	Period	Years	Total sediment	Drainage area	Annual rate of silting	Annual loss of storage	Survey agency and date
			Acre feet	*Square miles*	*Acre-feet per 100 square miles of drainage area*	*Percent*	
Spartanburg, S. C., city reservoir	1926 to 1924	8	463	92	63.0	2.14	Soil Erosion Service, 1934.
High Point, N. C., city reservoir	1927 to 1934	7	247	58	60.8	.84	U. S. Geological Survey and Soil Erosion Service, 1934.
Rogers, Tex., city reservoir	1922 to 1934	12	37.5	.55	568.2	1.90	Soil Erosion Service, 1934.
Elephant Butte Reservoir, N. Mex.	1915 to 1925	10.7	231,500	30,000	72.0	.80	Bureau of Reclamation, 1925.
Zuni Reservoir, Black Rock, N. Mex.	1910 to 1927	17	10,136	660	90.3	3.62	U. S. Indian Irrigation Service, yearly.
Roosevelt Dam Reservoir, Ariz.	1910 to 1925	15	101,000	5,760	116.9	.41	Salt River Valley Water Users Association, 1925.

TABLE 17.—*Acreage in each class of eroded land, by watersheds, as shown by erosion reconnaissance of the United States Soil Erosion Service Department of the Interior, November 1934*

Symbol	Erosion classes	Major watersheds					
		North Atlantic	Middle Atlantic	South Atlantic	St. Lawrence	Ohio and Lower Mississippi	Gulf coast
		Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
1	Practically no erosion (best crop land, with much mountain forestry land)	34,235,579	36,484,264	51,201,993	62,049,297	58,137,217	72,677,389
17	Little sheet erosion, some gullying (much good crop land along with mountain and hill forest land; erosion beginning locally)	1,169,762	138,299	118,770	1,261,429	12,900,903	3,851,853
18	Little sheet erosion, severe gullying (mostly timber and grazing)				182,539		73,733
2	Moderate sheet erosion (early stages of decline, fair to good crop land)	651,133	5,385,099	16,760,904	5,357,386	17,772,988	9,624,661
27	Moderate sheet erosion and some gullying (declining but damage not so advanced as on 28, much good land)	539,246	19,791,572	8,535,878	4,853,614	40,029,566	39,284,574
28	Moderate sheet erosion, severe gullying (steadily declining, much good land but abandonment beginning)	7,971	588,270	398,954	247,609	8,345,176	8,819,640
3	Severe sheet erosion (productivity greatly reduced, much submarginal)		340,328	692,663	18,732	1,443,971	1,254,841
37	Severe sheet erosion, some gullying (about 25 percent better than 38, mostly still in cultivation)	10,761	604,207	4,110,702	98,842	26,241,957	6,342,381
38	Serious sheet and gully erosion (about 50 percent essentially destroyed, mostly formerly cultivated, some good land but rapidly declining)		205,858	3,168,918	22,717	9,348,339	3,312,360
4	Moderate wind erosion (best western farm and grazing land)	387,998	31,087		2,453,509		
47	Moderate wind erosion, some gullying (still fairly good for crops and grazing, locally declining)	47,827			26,305		
48	Moderate wind erosion, severe gullying (fair to poor grazing land)						
24	Moderate sheet and wind erosion (good grazing and fair crop land, beginning to decline)	6,377	33,479		304,497		
24W	Chiefly scablands, locally subject to blowing (fair grazing to valueless)						
247	Moderate sheet and wind erosion, some gullying (fair to good grazing, damage slowly increasing)				131,922		
248	Moderate sheet and wind erosion, severe gullying (fair crop and grazing land, declining rapidly locally)				8,768		
348	Serious sheet and moderate wind erosion, severe gullying (partly destroyed, mainly grazing, rapidly declining)						
5	Severe wind erosion (largely submarginal for cultivation, fair grazing possibilities)	4,384	17,935		816,692	349,136	
57	Serious wind erosion, moderate gullying (some grazing, not so good as 5, steadily declining)				29,493		
58	Serious wind erosion, severe gullying (largely of no value)						
25	Moderate sheet erosion, serious wind erosion, no gullies (fair grazing)	26,740	182,939		133,515	78,117	
257	Moderate sheet erosion, serious wind erosion, some gullying (little value)				117,186		
35	Seriously eroded by wind and water, no gullies (largely of little value)						
357	Seriously eroded by wind and water, some gullying (largely of little value)						
6	Severely eroded by wind (largely essentially destroyed)	17,138			103,624		
9	Essentially destroyed, predominantly by gullying (formerly cultivated)		63,378	3,081,244		1,448,748	7,043,646
9A	Mainly badlands and stony lands, in West (generally overgrazed, fair grazing to valueless)						
R	Largely bare, above timberline (mainly valueless)						
	Total	37,104,916	63,866,715	88,070,026	78,217,676	176,096,118	150,285,078

TABLE 17.—*Acreage in each class of eroded land, by watersheds, as shown by erosion reconnaissance of the United States Soil Erosion Service, Department of the Interior, November 1934*—Continued

Symbol	Erosion classes	Major watersheds									Total acreage
		Winnipeg	Upper Mississippi	Missouri River	Arkansas and Red	West Texas	Rio Grande	Columbia River	Great Basin and Colorado	Pacific Coast	
		Acres	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*	*Acres*
1	Practically no erosion (best crop land, with much mountain forestry land)	10,417,464	41,174,135	27,496,896	46,587,063	5,329,292	5,099,329	16,315,262	11,923,799	51,868,104	530,997,083
17	Little sheet erosion, some gullying (much good crop land along with mountain and hill forest land, erosion beginning locally)	8,768	12,580,847	17,448,124	8,634,821	845,736	8,255,959	40,793,043	27,308,492	1,195,699	136,512,505
18	Little sheet erosion, severe gullying (mostly timber and grazing)		7,174	438,411	1,585,246	1,993			16,913,583	119,567	19,322,246
2	Moderate sheet erosion (early stages of decline, fair to good crop land)	428,050	3,102,362	1,758,397	5,779,181	3,069,107	1,105,195		19,120,428	10,043,616	99,958,507
27	Moderate sheet erosion and some gullying (declining but damage not so advanced as on 28, much good land)	540,043	28,728,375	40,647,664	28,851,830	8,397,114	8,119,791	6,278,901	9,471,931	7,979,089	252,049,188
28	Moderate sheet erosion, severe gullying (steadily declining, much good land but abandonment beginning)	11,160	14,915,273	51,355,899	11,816,211	1,810,946	12,633,184	54,994,845	70,871,851	4,762,746	241,579,735
3	Severe sheet erosion (productivity greatly reduced, much submarginal)	87,682		522,111	740,569	715,010	880,012		1,158,603	637,630	8,492,152
37	Severe sheet erosion, some gullying (about 25 percent better than 38, mostly still in cultivation)		19,928	7,508,795	10,125,077	1,946,446	124,350	842,954	680,731	79,711	58,736,842
38	Serious sheet and gully erosion (about 50 percent essentially destroyed, mostly formerly cultivated, some good land but rapidly declining)		395,765	11,425,232	17,742,105	3,594,528	21,334,305	21,608,076	32,779,825	2,658,369	127,596,397
4	Moderate wind erosion (best western farm and grazing land)	18,645,653	8,170,401	88,910,223	9,829,342	2,409,480	199,676	119,567	203,662		131,360,598
47	Moderate wind erosion, some gullying (still fairly good for crops and grazing, locally declining)		2,391	14,403,794	2,410,468		728,560				17,619,345
48	Moderate wind erosion, severe gullying (fair to poor grazing land)		21,522	876,834	660,407		1,806,256				3,365,019
24	Moderate sheet and wind erosion (good grazing and fair crop land, beginning to decline)			1,167,336	311,672	268,104		9,881,800	1,294,609		13,267,874
24W	Chiefly scablands, locally subject to blowing (fair grazing to valueless)							6,258,527			6,258,527
247	Moderate sheet and wind erosion, some gullying (fair to good grazing, damage slowly increasing)	107,610	270,620	26,490,546	1,116,711	335,213	288,555	797,112	87,682		29,625,971
248	Moderate sheet and wind erosion, severe gullying (fair crop and grazing land, declining rapidly locally)		57,392	15,349,341	34,674	37,066	2,189,270	3,574,255	7,947,956		29,198,722
348	Serious sheet and moderate wind erosion, severe gullying (partly destroyed, mainly grazing, rapidly declining)				291,938				7,866,738		8,158,676
5	Severe wind erosion (largely submarginal for cultivation, fair grazing possibilities)	6,655,887	3,670,315	12,701,986	14,864,279	2,178,090	3,298,550		10,287,904	278,989	55,124,147
57	Serious wind erosion, moderate gullying (some grazing, not so good as 5, steadily declining)		1,993	1,159,802	2,211,770		1,043,819				4,446,877
58	Serious wind erosion, severe gullying (largely of no value)				78,117						78,117
25	Moderate sheet erosion, serious wind erosion, no gullies (fair grazing)				1,230,348	84,494		4,324,333	1,691,075		7,751,561
257	Moderate sheet erosion, serious wind erosion, some gullying (little value)	117,973	22,094	1,413,597	1,250,797	619,357	1,066,934	478,267	1,347,892		6,441,097
35	Seriously eroded by wind and water, no gullies (largely of little value)				337,179				1,944,428		2,281,607
357	Seriously eroded by wind and water, some gullying (largely of little value)				2,067,071		3,759,726		403,339		6,230,136
6	Severely eroded by wind (largely essentially destroyed)	110,400	18,334	355,113	3,152,777	196,487	194,553	3,628,059	962,080		8,738,565
9	Essentially destroyed, predominantly by gullying (formerly cultivated)	53,008		49,223	2,033,442	95,796				1,275,380	13,143,865
9A	Mainly badlands and stony lands, in West (generally overgrazed, fair grazing to valueless)			10,740,842	5,049,473	953,017	11,713,530	404,933	82,766,871		111,628,666
R	Largely bare, above timberline (mainly valueless)			119,567	239,134		79,711	1,441,977	956,535	1,841,330	4,678,254
	Total	37,183,698	113,165,921	332,339,733	179,031,702	32,887,276	83,921,265	171,741,911	307,990,014	82,740,230	1,934,642,279

basin during 1927. The other reservoirs in the same regions of excessive erosion are definitely on the way to a similar fate. This phase of sedimentation is destined to continue at progressive rates in the future in the absence of effective erosion control. Table 16 presents data on silting of certain reservoirs in different sections of the United States.

2. Floods: Accelerated erosion tends to increase frequency and height of floods through increased volume and flashiness of run-off and decreased discharge capacity of alluvial channels. The volume of run-off is increased chiefly by lowered permeability of eroded soils and lessened time for percolation.

The water-discharge capacity of alluvial channels leading out of regions of accelerated erosion is decreased by accumulations of sediment, due to overloading of the stream by abnormal waste from headwater areas. Flood discharge is thus more largely diverted to overbank area, where velocities are lower and flood levels of given discharges are correspondingly elevated.

3. Water Supply: Accelerated erosion tends generally to increase surface run-off at the expense of natural replenishment of underground waters. This must tend to lower the water table, both locally and generally, in regions of notably accelerated erosion. There has been complaint of a gradual lowering of the water table in many sections of the United States critically dependent upon underground water supply, during the time of agricultural acceleration of erosion. This has continued through such a variety of rainfall periods as to indicate possibility, if not probability, that excessive run-off, due to man-induced erosion, is a major factor of waning underground water supply.

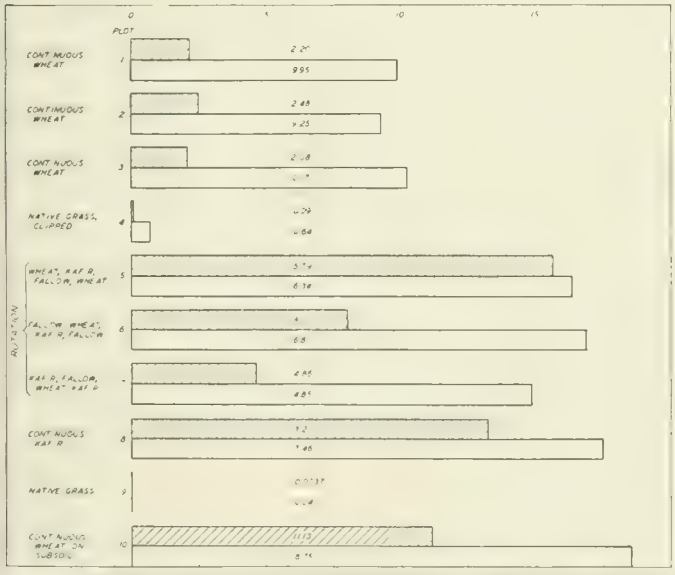


FIGURE 40.—The chart teaches two distinct lessons in land use practices at Hays, Kans. First, the function of the topsoil is indicated when its absorptive capacity is compared with that of exposed subsoil. The average annual loss from continuous wheat on land with a topsoil was 2.20 tons per acre, compared with an average annual loss of 11.13 tons per acre on land with no topsoil planted to continuous wheat. The second lesson shows that the use of a rotation which includes a clean cultivated crop and the practice of fallowing increases annual soil loss over that from land in a continual close-growing crop. It shows, also, that the soil loss from any annual crop is much greater than that from the native grass cover.

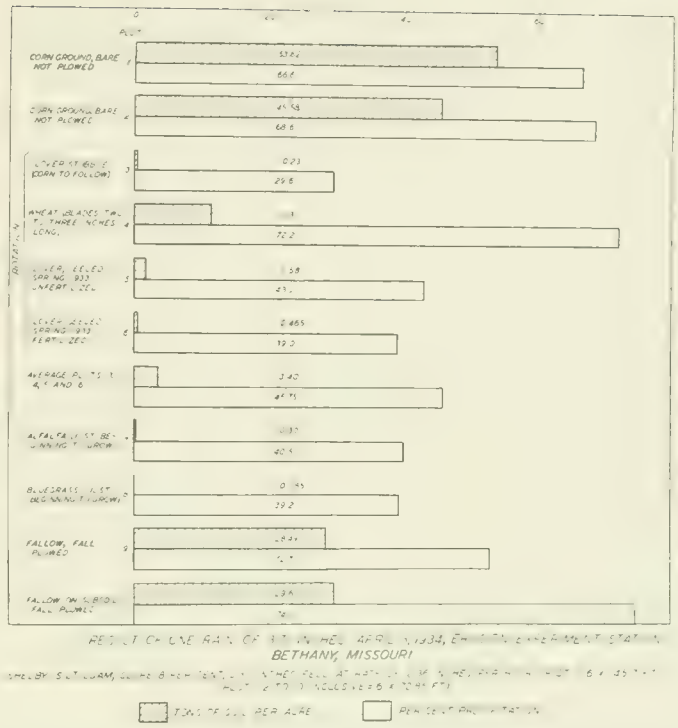


FIGURE 41.—At the Bethany station, corn stubble and fallow land, essentially bare land, lost as run-off as much as 74.5 percent of one rainfall and suffered a maximum soil loss of 53.62 tons per acre. In marked distinction, those plots in erosion-resisting, close-growing crops—alfalfa, clover, and bluegrass—suffered almost no soil loss from the same rain, and 40 to 59 percent less run-off.

Principles of Safe Land Use: The national soil-erosion reconnaissance recently completed by the Soil Erosion Service portrays an enormous wastage of the soil resources of the Nation. The conservation of this basic resource becomes an imperative need for the maintenance of sustained land productivity.

The past practice of clearing and cultivating land without regard to risks of wastage of soil and water resources has been nothing short of suicidal agriculture over extensive areas of the Nation's indispensable good lands. In general, level land and land of high absorptive capacity situated in regions of gentle rainfall have not been seriously damaged by erosion. Special precautions for safe usage within such areas are not required. In other cases, however, where the risks of erosion wastage are present to varying degrees, special measures of erosion prevention and control are indicated and become the concern of the landowner and of

the State and Federal Governments. Safeguards for the sustained utility of the land for this and future generations require action by the State or National Government where economic pressure under self-interest of the landowner imposes those uses of the soil that are destructive of its future utility. Improved methods of cultivation and cropping will be adequate over large areas to safeguard the utility; but rededication to other uses as a precaution against further soil wastage is required over other areas, both small and large.

The safe usage of land in national economy embodies a few simple but fundamental principles. They are:

1. The virgin soil profile with its natural mantle of vegetation represents conditions of maximum absorption of precipitation waters and of maximum erosion control.

2. Soils cleared of their natural vegetative cover are subject to different intensities of erosion, varying with the physical and chemical composition of the soil, slope gradients, and type of rainfall.

3. Absorptiveness and erosivity of soils are markedly influenced by the contents of organic matter.

4. Wastage and destruction of cultivated soil by both sheet and gully erosion are influenced by farm methods, such as crop rotations, green manuring, liming, fertilizing, plowing and cultivation, whether on contours or not, cropping in contour strips, and terracing.

5. Safe cultivation for sustained utility is limited to slope gradients up to certain maxima, varying with inherent erosivity of the soil, maximum rates of rainfall, and the application of practical measures of erosion prevention.

6. Soils within regions which cannot be safeguarded from destructive wastage with practical measures of erosion prevention should be withdrawn from cultiva-

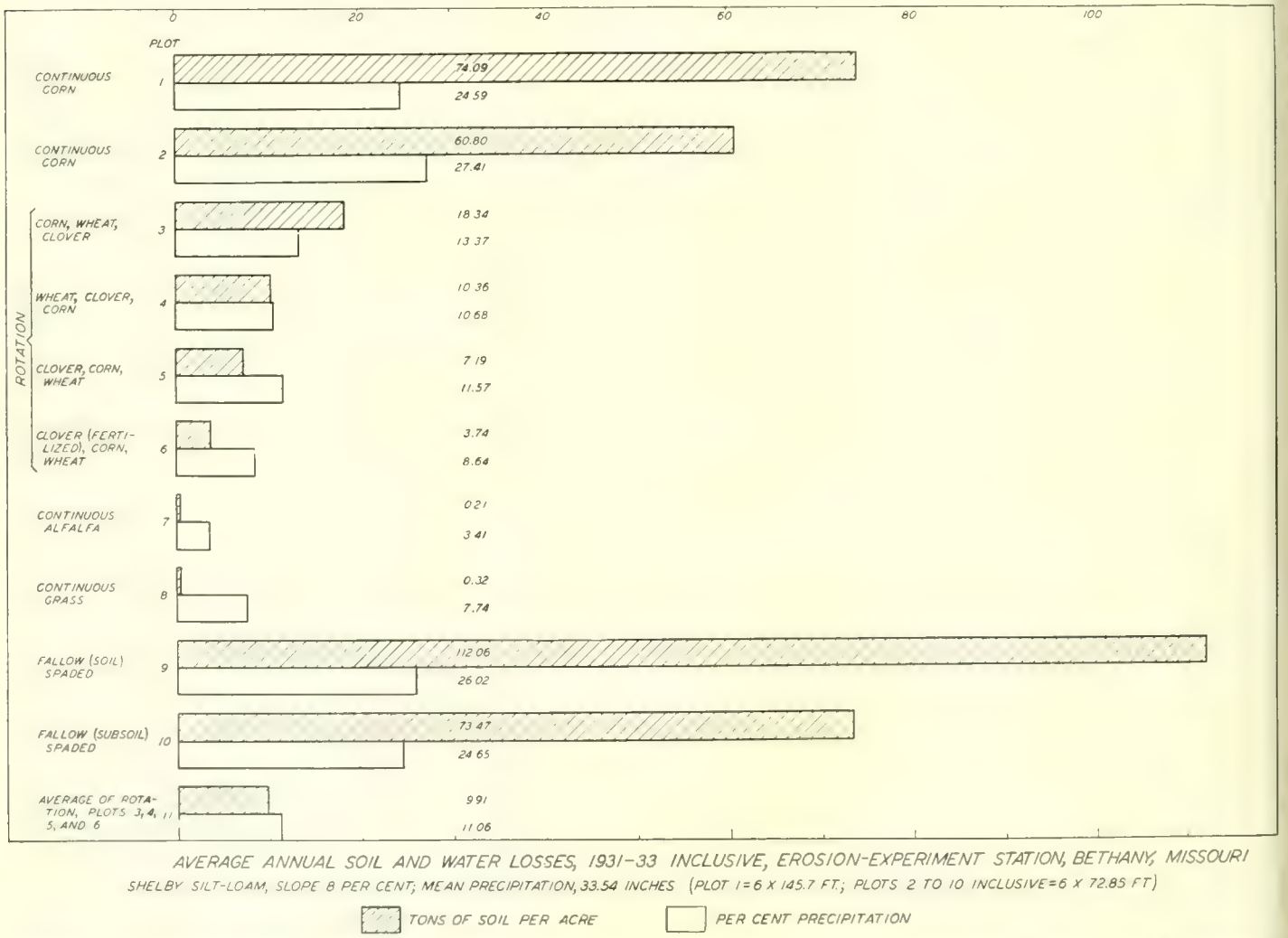
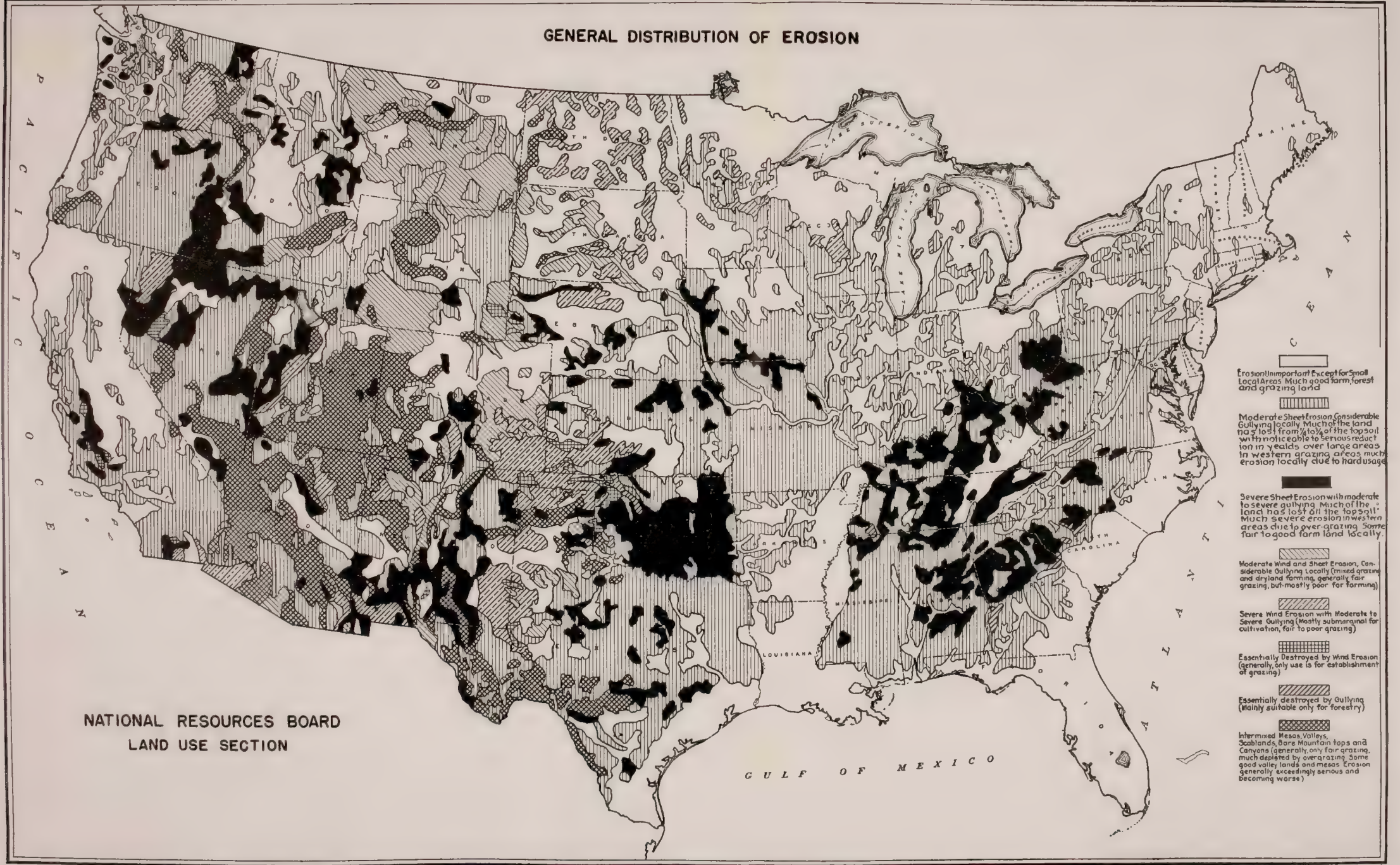


FIGURE 42. The chart shows average annual soil and water losses resulting from a continuous clean cultivated crop; from the practice of fallowing; from a 3-year rotation; and from continuous grass or legumes. It is outstanding that the land used continually for corn or left fallow, both common practices, suffered an average annual soil loss of 86.43 tons per acre, while the land in rotation suffered an averrge loss of 9.91 tons per acre, and the land in grass or legumes suffered an annual loss of less than one-third ton per acre. These results indicate the effectiveness in checking erosion of close-growing crops, whether grown alone or in suitable rotations.

MAP

GENERAL DISTRIBUTION OF EROSION


PACIFIC OCEAN
LAKE SUPERIOR
LAKE MICHIGAN
MAINE
ATLANTIC OCEAN
NORTH DAKOTA
MINNESOTA
MONTANA
WISCONSIN
MICHIGAN
NEW YORK
SOUTH DAKOTA
WYOMING
NEBRASKA
IOWA
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
NEVADA
UTAH
COLORADO
KANSAS
MISSOURI
KENTUCKY
WEST VIRGINIA
VIRGINIA
NORTH CAROLINA
TENNESSEE
ARIZONA
NEW MEXICO
OKLAHOMA
ARKANSAS
MISSISSIPPI
ALABAMA
GEORGIA
SOUTH CAROLINA
LOUISIANA
TEXAS
GULF OF MEXICO
Erosion Unimportant Except for Small Local Areas Much good farm, forest and grazing land
Moderate Sheet Erosion Considerable Gullying locally Much of the land has lost from ¼ to ¾ of the topsoil with notice able to serious reduction in yealds over large areas in western grazing areas much erosion locally due to hard usage
Severe Sheet Erosion with moderate to severe gullying Much of the land has lost all the topsoil Much severe erosion in western areas due to over-grazing Some fair to good farm land locally
Moderate Wind and Sheet Erosion, Considerable Gullying Locally (mixed grazing and dryland farming, generally fair grazing, but mostly poor for farming)
Severe Wind Erosion with Moderate to Severe Gullying (Mostly submarginal for cultivation, fair to poor grazing)
Essentially Destroyed by Wind Erosion (generally, only use is for establishment of grazing)
Essentially destroyed by Gullying (Mainly suitable only for forestry)
Intermixed Mesas, Valleys, Scablands, Bare Mountain tops and Canyons (generally, only fair grazing, much depleted by overgrazing Some good valley lands and mesas Erosion generally exceedingly serious and becoming worse)

NATIONAL RESOURCES BOARD
LAND USE SECTION

MAP PREPARED BY THE SOIL EROSION SERVICE

92588—34. (Face p. 170)

tion and rededicated to permanent vegetative cover, such as pasture and/or forests.

7. Eroding areas, where gullies and wind erosion are progressively destroying the utility of land, require the application of artificial measures of control to aid in the establishment of vegetative cover, which represents the most economical and final method of erosion prevention.

Present Public Policies with Reference to Erosion: In order to study in a systematic way the character and extent of erosion and methods for its control under a wide variety of soil and climatic conditions, the Department of Agriculture began in 1929 the establishment of erosion-control experiment stations. Their work has been consistently established and carried on in full cooperation with State experiment stations and other local agencies directly concerned with the erosion problem. The aggregate area served by the present stations is approximately 225 million acres. Each station already has contributed a great amount of constructive information, not only to the public at large, but to the various extension and service agencies concerned with getting the facts home to the farmer. This information has dealt not only with the relative rates of soil and water losses from various soils under definite conditions of slope, climatic relations, surface exposure, and other conditions, but also has included well-defined suggestions as to procedure in the establishment of proper methods of control under practical working conditions in the field. The development of this work has been particularly timely in connection with the broad program of conservation that has been adopted by the Administration.

An Erosion Reconnaissance of the United States: To provide a basis upon which to formulate a national program of soil and moisture conservation a soil-erosion reconnaissance was made of the entire country by the Soil Erosion Service. The field work was made by 115 trained soil erosion specialists, who visited every county in the United States and delimited boundaries of erosion classes and designated them by appropriate symbols on county maps. The county maps were compiled on State maps, which were then compiled on a national map. The detailed national map corresponding to the classes shown in table 17, is too large to be included in this summary report. Table 17 shows the distribution and acreage of each of the 28 classes of eroded land by major watersheds of the Nation taken from the master erosion reconnaissance map. The accompanying map is a generalized erosion map, showing eight broad erosion classes. The land acreages falling under these classes are shown in table 18.

TABLE 18. *Summary table of erosion conditions in the United States*

[A generalized table of 28 erosion classes combine I into 8 classes use I in the accompanying generalized erosion map of the United States]

Symbol	Description of generalized erosion class	Acres
1	Erosion unimportant except for small local areas (much good farm, forest, and grazing land)	798, 870, 186
2	Moderate sheet erosion. Considerable gullying locally. Much of the land has lost from ¼ to ¾ of the topsoil with noticeable to serious reduction in yields over large areas. In western grazing areas much erosion locally due to hard usage	612, 909, 676
3	Severe sheet erosion with moderate to severe gullying. Much of the land has lost all the topsoil. Much severe erosion in western areas due to overgrazing. Some fair to good farm land locally	194, 825, 391
4	Moderate wind and sheet erosion, considerable gullying locally (mixed grazing and dryland farming; generally fair grazing, but mostly poor for farming)	101, 235, 607
5	Severe wind erosion with moderate to severe gullying (mostly submarginal for cultivation; fair to poor grazing)	82, 453, 512
6	Essentially destroyed by wind erosion (generally only use is for establishment of grazing)	8, 738, 565
7	Essentially destroyed by gullying (mainly suitable only for forestry)	13, 143, 867
8	Intermixed mesas, valleys, scablands, bare mountain tops, and canyons (generally only fair grazing) much depleted by overgrazing. Some good valley lands and mesas. Erosion generally exceedingly serious and becoming worse	122, 565, 447
	Total	1, 934, 642, 279

Erosion-Control Demonstration on a National Scale: In order to carry through practical regional programs of correct land utilization embodying a coordinated plan for erosion-control procedure, such as must be employed to bring about maximum results in control of soil erosion, flood reduction, and needed reorganized farm practice, the Soil Erosion Service of the Department of the Interior has put into effect a plan of operation on demonstration areas selected in regions throughout the United States where the risk of erosion wastage is high. Most of the work is being carried out on the watershed method of treatment. Though predicated upon a unified method of attack, it is sufficiently flexible in working details to permit adjustment in every important step, not only to the requirements and adaptabilities of different kinds of land, as determined by soil, slope, rainfall, and type of agriculture, but to those conditions permitting necessary coordination with the broader regional requirements of land use.

Local Forests: There is splendid opportunity to expand the erosion projects in connection with retirement of submarginal areas from production and the rehabilitation of scantily forested abandoned areas, as those in many parts of the Virginia-Carolina-Georgia-Alabama piedmont country. The larger, more compact areas of such eroded and erosive lands may be effectively handled by inclusion in national forests. The smaller farm tracts can best be handled as an individual

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7. Eroding areas, where gullies and wind erosion are progressively destroying the utility of land, require the application of artificial measures of control to aid in the establishment of vegetative cover, which represents the most economical and final method of erosion prevention.

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2	Moderate sheet erosion. Considerable gullying locally. Much of the land has lost from ¼ to ¾ of the topsoil with noticeable to serious reduction in yields over large areas. In western grazing areas much erosion locally due to hard usage	612,909,676
3	Severe sheet erosion with moderate to severe gullying. Much of the land has lost all the topsoil. Much severe erosion in western areas due to overgrazing. Some fair to good farm land locally	144,827,491
4	Moderate wind and sheet erosion, considerable gullying locally (mixed grazing and dryland farming; generally fair grazing, but mostly poor for farming)	101,235,607
5	Severe wind erosion with moderate to severe gullying (mostly submarginal for cultivation; fair to poor grazing)	82,474,342
6	Essentially destroyed by wind erosion (generally only use is for establishment of grazing	8,738,565
7	Essentially destroyed by gullying (mainly suitable only for forestry	13,143,865
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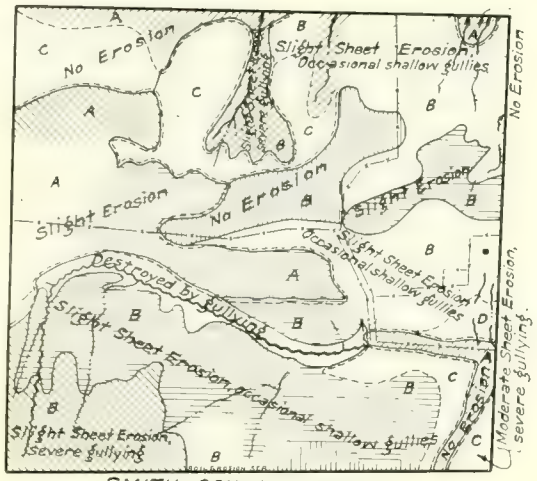
NORTHEAST TEXAS — DUCK CREEK PROJECT



SMITH COUNTY, TEXAS
100.2 ACRES

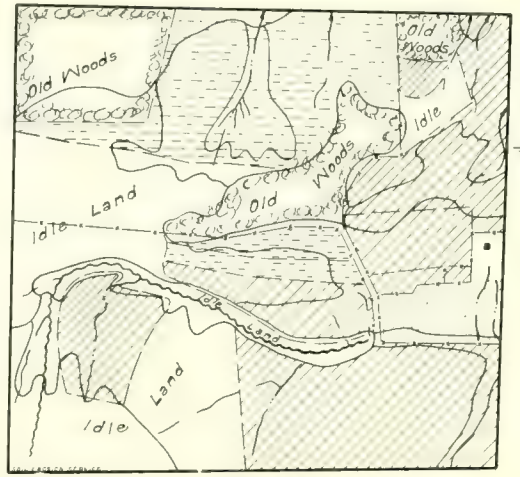
PHYSICAL CONDITION OF LAND

LEGEND

- A 0% to 3% slope
- B 3% to 8% "
- C 8% to 10% "
- D Over 10% "
- Boundaries of slope areas.
- Boundaries of eroded areas.
- Fences
- Shallow gullies
- Deep gullies

SOIL TYPES

- Kirvin fine sandy loam.
- Kirvin stony loam.
- Nacogdoches gravely fine sandy loam.
- Bowie fine sandy loam.
- Ruston fine sandy loam.
- Hannahatchie fine sandy loam.



PRECEDING LAND USE

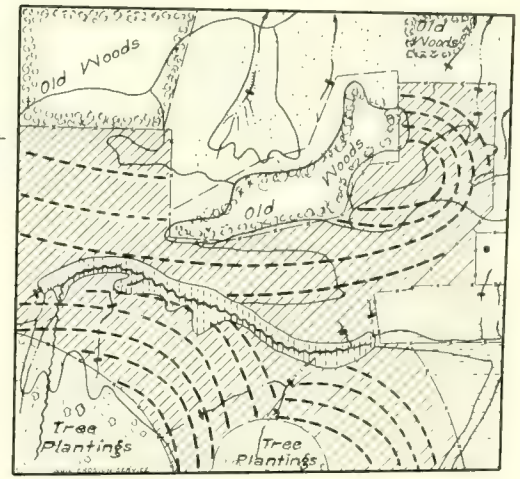
LEGEND

LAND USE

- Tilled crops
- Hay & legume crops.
- Pasture

SYMBOLS

- Shallow gullies
- Deep gullies
- Field boundaries
- Fences
- Boundaries of eroded areas



REORGANIZED LAND USE

LEGEND

NEW TREATMENT

- Tilled crops
- Terraces and strips of dense crops
- New seedings
- Pasture
- Idle land

SYMBOLS

- Shallow gullies
- Deep gullies
- Fences
- Field boundaries
- Check dams

PRECEDING CONDITION OF FARM

1. Farm 100.2 acres. Cultivated land. 62.6 acres
2. Sheet erosion serious. On 79% of entire farm, ¼ to all of top soils removed.
3. Gullies serious. 12% of land destroyed for cultivation.
4. No definite cropping rotation
5. Extremely poor pasture
6. Large percentage highly erosive crops
7. Eighteen irregular shaped fields

REORGANIZED FARM

1. Farm 100.2 acres. Retired from cultivation, 10 acres.
2. Sheet erosion controlled on entire farm by strip cropping, seeding, new type terraces, contour farming and contour furrowing.
3. Gullies controlled on 64 acres with soil saving dams
4. Definite rotations for uninterrupted erosion control.
5. All pastures reseeded and contour furrowed.
6. Low percentage erosive crops. Cotton reduced 40%.
7. Nine fields; rearranged for efficient handling and cropping.

For National Resources Board by Soil Erosion Service

FIGURE 43.—The plate shows a representative farm in northeastern Texas on the Duck Creek erosion control project. The physical condition of the land is illustrated in the first figure, showing actual conditions of sheet and gully erosion, the classes of land slope, and the soil types. Sheet erosion and gullying are shown as serious, 12 percent of the farm land having been destroyed for cultivation.

The second figure shows the land use before cooperation with Soil Erosion Service. The idle land not in crops is subject to extreme erosion because of only meager volunteer grass and weed growth. No measures for controlling erosion have been used. Practices of planting clean tilled crops, as corn and cotton, up and down hill, have accelerated washing of the soils.

The third figure shows reorganization of the farm to conserve the soil under supervision of the Soil Erosion Service. Measures for controlling erosion have been inaugurated on every field on the farm. Strip cropping, contour farming, contour furrowing, seeding, improved type terraces, check dams, and/or a suitable cropping system control erosion on every acre. Ten acres, unsuited for cultivation because of sheet erosion and gullying, were permanently retired from cultivation by seeding and planting to trees. Gullies have been stabilized by seedings, tree plantings, and check dams. All cultivated fields are strip cropped with hay, small grain, or legumes, which alternate in narrow bands or strips with clean tilled crops as corn or cotton. A 5-year cropping program to provide complete erosion control on the farm will be carried out by the farmer under a cooperative agreement.

farm project; but between these extremes there are numerous areas that offer opportunity for worthwhile development upon some suitable community, town, county, or State basis.

Cooperation: The closest kind of cooperation between land users and erosion-control specialists is necessary for the success of any of this soil-saving and water-control work. Thus far, the farmers, and even the Indians of the Navajo Reservation, are giving splendid cooperation. From 70 to about 100 percent of the farmers of the various regions have agreed to go squarely along with the regional programs now being rushed by the Soil Erosion Service, contributing labor and teams and tools, fence posts, etc. Cooperation with State agricultural colleges, experiment stations, and extension services is in effect in all field operations, and must be closely maintained at all times.

The projects of the Soil Erosion Service are largely demonstrational, but it has been found necessary to carry on a certain amount of experimental work in some of those regions where no effort has ever been made to determine, for example, at what declivity plowing should cease and the planting of permanent soil-saving crops should begin, or how much grazing the different slope declivities of the different major soil types will withstand. Additional information about erosion control and increased absorption of rainfall is being accumulated as the demonstrational work advances. Each watershed project will show how a complete job of surface treatment for erosion control will affect the flood and silting problem; each project is necessarily of an experimental nature—and represents the first experiment of the kind carried out in America. (See fig. 43.)

During the summer of 1934 a small number of Civilian Conservation Corps camps were used on erosion projects, largely in connection with gully control. The soil erosion service has a working agreement with the Emergency Conservation Works Administration by which a number of Conservation Corps crews have been assigned to the Erosion Service to assist in the construction of dams and the planting of trees as measures of gully control, and to some extent to assist with terrace construction. The 51 camps assigned to this service are located on or adjacent to the Soil Erosion Service projects. This work is supplemental to the major program of the Soil Erosion Service designed to assist the farmer in revising his general farming practices by the relocation of fences, contour cultivation, substitution of forage for cultivated crops, and in installing such other measures as are necessary for erosion control.

A guiding policy throughout has been that the landowner should contribute substantially to the work done on his land, in the form of materials, labor, and farm power

Under the supervision of the Forest Service, 124 Conservation Corps camps of 200 men each were working exclusively on erosion control, while many other camps devoted part time to this work. They work in direct cooperation with the State conservation commissions, both in forestry work and in erosion control work, largely on privately owned lands. It seems desirable that all soil erosion work on privately owned land be conducted on a common policy as to relations with private landowners.

Under the present contracts of the crop adjustment program of the Agricultural Adjustment Administration certain steps have been taken to encourage the use of substitute crops that tend to check erosion. Authorized uses to which contracted acres may be put are: Fallow or idle; soil-improvement or erosion-prevention crops; food or feed crops for home use, and other noncommercial production.[2]

The replacement crops section has consistently encouraged the planting of erosion-prevention and soil-building crops on the acreage contracted out of production of basic commodities, where such plantings will not result in the disturbance of established agricultural relationships.

Principles of a National Policy of Erosion Control—Objectives: The principles of a national policy of erosion control are to restrict in the largest possible measure the erosive forces that are now steadily depleting the soil resources of an enormous aggregate area. Such a policy is an integral part of any intelligent plan looking toward better land utilization and conservation of our basic natural resource. A national policy of erosion control should aim at coordinated mobilization of all efforts, National, State, and local, that can be directed toward early and comprehensive action. A program should be developed to make possible the arresting of sheet erosion, the checking of gullying, and the rehabilitation of badly eroded lands where these impoverishing agencies are affecting valuable agricultural areas. Such efforts must meet the test of practicability, and have intelligent and popular backing. It is recognized that it is not possible to prevent erosion completely, or fully to reestablish the conditions of relative land stability which existed prior to settlement and use of lands. It is possible, however, by modern techniques in land management to reduce erosion on most of the declining areas of more valuable soil to such an extent that the land may continue to be used almost indefinitely. A

[2] These restrictions were greatly relaxed on May 29, 1934, to permit increased production of forage, because of the drought. Indications are that the 1935 regulations will carry over some of this greater liberty.

Cooperative arrangements were entered into between the Agricultural Adjustment Administration and the Soil Erosion Service whereby within the boundaries of soil erosion projects land being retired from agricultural production could continue to be used for agricultural purposes, provided that a larger area of sloping, highly erosive land having an equivalent productivity was retired from agricultural production and planted to erosion-resisting grasses or trees, and further provided that the total percentage reduction in the particular crop concerned was maintained.

national policy of erosion control should contemplate initiation of erosion-control measures on all land now seriously suffering from erosion within about 10 years in order to secure reasonable control of erosion within about 20 years, and to establish preventative measures on practically all of the better lands of the country subject to this hazard within a generation.

Need for Public Regulation: It should be the aim and policy of any national erosion-control program to avoid the imposition of restrictive legal regulations on the use of the land unless of absolute necessity. There are many situations where it will be possible to obtain voluntary cooperation from the owners of property in the direction of modifying land use practices for the purpose of controlling erosion. There will exist other situations, however, where for one reason or another it will be impossible to obtain satisfactory voluntary cooperation. In such instances the necessity will arise for the creation of State or local land use control, based on the specific adaptabilities of various types of soils, as affected by topography, climate, types of agriculture, and other factors. The establishment of such State or local measures could be advantageously encouraged through the granting of Federal aid for the control of erosion in such regions where necessary controls are set up, while withholding aid from regions which refuse to cooperate.

Regulations: Because of the highly complex and technical nature of the problems involved and the necessity for adequate coordination of the measures adopted in various parts of the country, particularly on interstate watersheds, the Federal Government should assume responsibility for coordinating erosion work generally. The Federal Government must recognize its responsibility for close coordination of its own activities dealing with the subject of erosion, including the interests of departments and agencies now entrusted with responsibilities related to land and agriculture and credit. The Federal Government must be prepared to finance adequately any program which is undertaken.

A fairly detailed survey should be made of critical areas where the erosion menace is serious to determine the needs for prevention and correction of erosion. This survey would show the character of erosion, the extent of present and prospective damage, and the types of control measures needed. On the basis of such a survey the various interested Federal agencies should cooperate with the States in preparing a detailed erosion classification map.

Legislation should be enacted establishing a method of Federal-aid support for erosion-control work on State and private lands. This legislation should assure flexibility in Federal contributions so as to make certain that the share of the cost assumed by the Federal Government would be proportionate to distinctly Federal or public benefits derived from control work. The appropriation of adequate funds, of course, will be essential for carrying on this type of public work.

Adequate Federal appropriations should be provided to complete within a reasonable period necessary erosion-control work on federally owned and Indian lands.

The Federal and State Governments and other public entities should acquire, as part of their land retirement program, those highly erosive lands unsuited to continuing operation under private ownership, because of the danger inherent in private ownership of these lands of neglecting soil conservation. Erosion control is one of the many basic factors which should determine the retirement of land. Transfer from agricultural to some other use, with little or no added expense in many cases, will halt erosion which now threatens to destroy for countless future generations the remaining values of many privately owned areas. (See section on retirement of poor lands, pp. 175–184.)

Federal agricultural credit, now estimated on the basis of the anticipated productivity of lands, should emphasize the factor of loss in productivity due to destructive erosion in such a way as to encourage the use of protective methods. Appraisers and members of cooperative credit agencies must be gradually educated to recognize the destructive forces of erosion.

Through selective extension of Federal aid for the purpose of controlling erosion, and through other methods, the States should be encouraged to pass legislation authorizing:

1. Cooperation with the Federal Government in erosion-control work.
2. The organization of conservation districts, or similar legal subdivisions, with express authority to carry out measures of erosion control.
3. The establishment of State or local land use zoning ordinances, where lack of voluntary cooperation makes such ordinances necessary in the public interest.

In the production adjustment programs of the Agricultural Adjustment Administration, increasing emphasis is and should be given to relating lands temporarily retired from production of basic crops to soil erosion-control programs. There is wide prevalency of serious soil erosion problems on farms devoted to basic crops. Increased emphasis on ersoion-control programs will provide an avenue rich in possibilities of soil conservation and land rehabilitation which in many cases alone may justify the temporary retirement of limited areas from basic crop production. Planting to grasses, to erosion-preventing crops, and to trees are possibilities.

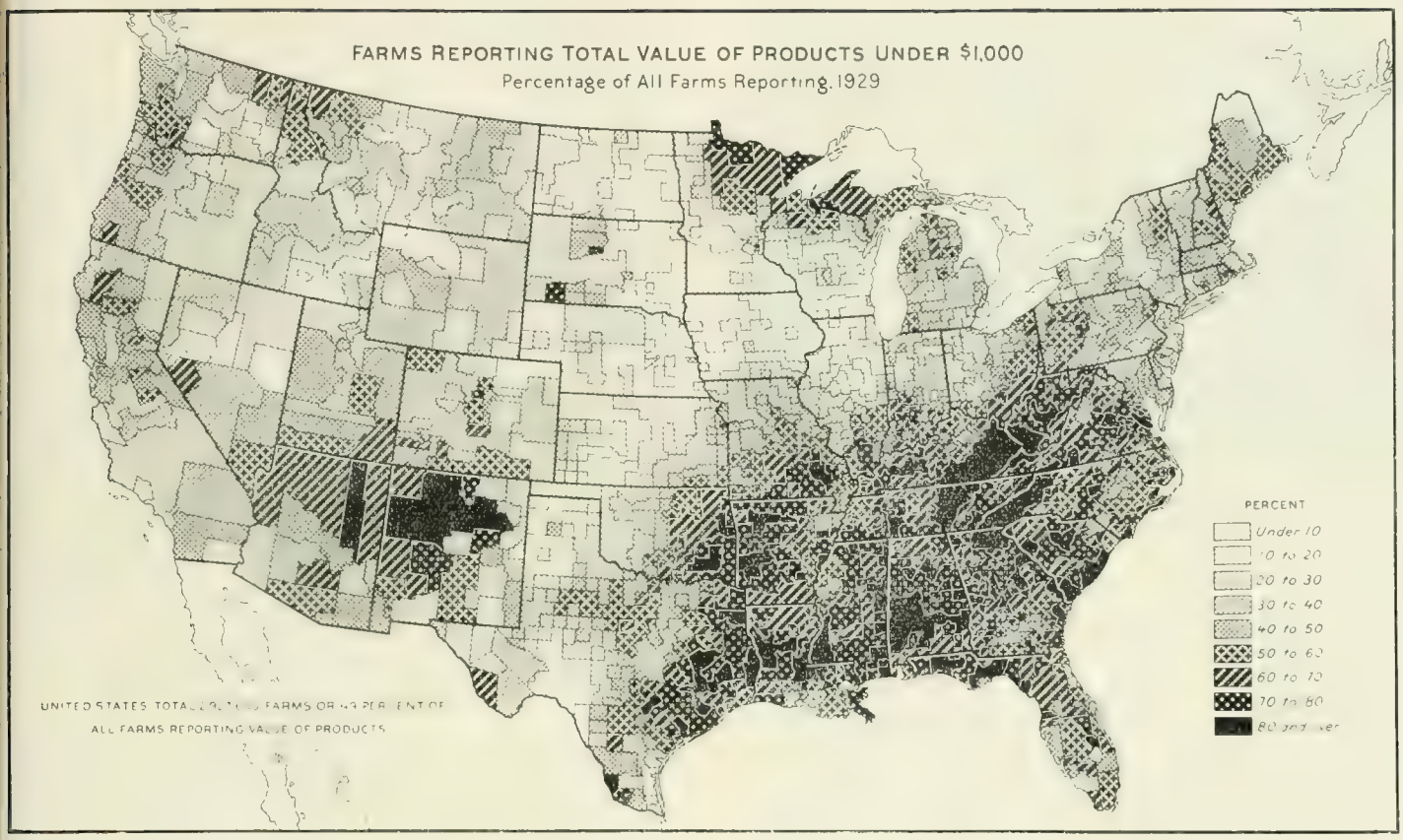


FIGURE 45.—Nearly half the farms in the United States in 1929, a fairly prosperous year, produced less than $1,000 worth of products. In the triangle from northern Illinois to North Dakota and the Panhandle of Texas fewer than a fourth of the farms in most counties produced less than $1,000 worth of products. But south of the Potomac and Ohio Rivers, also in southern Missouri, in southeastern Oklahoma, and southeastern Texas there were many counties in which about three-fourths of the farms, including cropper holdings, produced less than $1,000 worth of products. The half of the farms in the United States that produced less than $1,000 worth of products, contributed only about 12 percent to the total sales from all farms. Evidently a very large proportion of the farmers of the United States produce little, if any, more farm products and sell little, if any, more than the typical European peasant.

for recreation, etc., amounted to only 4 percent of the total, compared to 10 percent for the $350 group. (See table 19.) Housing has not been included in the discussion above. There is much more variation in the housing on this poor land than in the other items. In areas where farming was prosperous at one time and in instances where the farmer has moved onto the land with some savings, the houses may be fairly adequate. But on most of these poor farms the housing is relatively no better than the other living provided. Even the amount of room available is often inadequate, and facilities like running water, telephones, and electricity are practically lacking.

Complete relief data for poor land are not available, but data for counties having large areas of this poor land indicate that the relief burden is much above the average for the United States. In some of these counties over half the population was receiving relief in May and June 1934. For the families on the distinctly problem land, an indication is obtainable from estimates made by the project managers of 37 of the agricultural demonstration projects, at the request of the Land Policy Section. The percentages by projects varied from 4 to 95, and the average for all was nearly 37 percent. In some areas the peculiarly independent spirit of the people has caused them to avoid asking for relief as long as possible, while in some cases probably ignorance of how or where to obtain relief has been a factor. In some of the areas where a low subsistence standard prevails the population has been less affected by economic depression than in commercial farming areas and, being accustomed to severely low standards, has not sought relief.

The burden of relief in these poor land areas is further increased during depression times by the influx of the dispossessed and unemployed. Over vast areas of the country, but particularly near the industrial centers, this poor land has served as a cushion to absorb some of the shocks of economic dislocation. Since the land has small productivity, the property rights are not very valuable, and in the past decade many houses were left vacant. Consequently, these poor lands have been a refuge for the unfortunate. Since the newcomers have brought little wealth and have produced comparatively little on the land, they have increased the relief load in the areas. In one township studied in southern Indi-

FIGURE 46.—Even Iowa has its problem farms. Although it is our leading agricultural State, there are numerous areas upon which farming is uneconomic and the best uses of which are silviculture or extensive pasture.

ana population increased 36 percent from 1928 to 1933, with the incoming families adding but 1 percent to the taxable property of the township. This increased poulation not only adds to the relief load of the local government but requires the maintenance of roads and provision of schools. In one county in eastern Michigan 12 schools were reopened in one recent year, due largely to the immigration to cheap, poor land.

Costs of local government vary widely in the different areas of poor land. In some densely populated areas of poor land, particularly in States which have offered little assistance to local units of government in the attainment of high standards of public services, the total dollar costs per capita of local government are very low. These expenditures buy only the minimum of services. Salaries of public officials are low, roads are poor, and school buildings often inadequate. In many cases the schools have heavy enrollment per teacher, giving a minimum cost for providing instruction.

Some economies in government might be possible through reorganization, particularly through consolidation of small counties. But in general these areas are at the bedrock of local expenditures.

In the poor land regions of some States we find a very expensive system of local government, with costs high in relation to both population and taxable property. Particularly in the farm settlements in the cut-over country, farm homes or small communities are widely scattered. Here many forces converge to cause high costs of local government. The sparse settlement requires the administrative costs of the numerous local governments to be apportioned among a small population. The scattering of families necessitates many miles of roads for a few farms; a school for a few children. In five typical northern Wisconsin counties 38 towns had more than 1 mile of road per farm. This costs the State $40 per mile in town road aid. There are literally hundreds of small schools throughout this vast sparsely populated cut-over frontier. The furnishing of such facilities is a heavy cost both to the State and to other parts of the counties, and in this type of region very significant savings in school and road costs could be effected by a redistribution of the population. The thousands of communities built on poor and ill-used land fall between these two extreme types—poor land areas of dense population where costs are now at a minimum, and the sparsely settled frontier country where many units of local governments receive generous State assistance, and where high government costs can probably be materially reduced by a reorganization of the communities.

The costs of local government on poor land in States which maintain high standards of services may be illustrated by two Middle Western States, Wisconsin and Indiana, which have very different types of poor land areas. In the former State, in 1932, total costs of local government exceeded 5 percent of the true valuation in practically all of the northern cut-over counties, as well as in five counties in the light-soils area in the central part of the State. In one county these costs amounted to 9 percent. In marked contrast, the local government costs in the rural counties with richer soil of southern and eastern Wisconsin averaged slightly more than 3 percent of true value. Similarly in southern Indiana, total local government costs in 1931 varied from 4 percent to almost 7 percent of full value. In the better agricultural areas local government costs were usually below 3 percent.

In these States the systems of State aids or subventions are highly developed. In the better agricultural counties about 10 percent, or less, of the total costs of

FIGURE 47.—A growing farm family and its squalid home. Such conditions are commonly seen in those portions of southern Indiana where the degree of economic self-sufficiency is high.

local governments were borne by State aids. In the poorer areas subventions amounted to 25 to 40 percent of local governmental costs.

Notwithstanding the assistance of subventions, property tax rates for the support of local government were from 50 to 75 percent higher in the poorer areas than in the better farming regions of these States.

That this burden of taxation has been greater than the owners of property could, or would, bear is shown by the high rate of tax delinquency and reversion in northern Wisconsin and other cut-over regions. While delinquency has not reached as great proportions in other areas, such as southern Indiana, chronic tax delinquency and reversion have been frequent.

The high costs of local government in poor land areas, if a high standard of facilities is maintained, both to the people in the area and to the remainder of the State, point to the fundamental consideration that the costs of government are determined by the pattern of institutions and the population of the community. In the American scheme of things, agricultural settlement is dispersed over the land. Under free play of land sellers and land settlers, this means a sparse population in a new country; if the land is poorly adapted to farming, settlement remains scattered indefinitely. This suggests that the only alternative to expensive government in poor land areas is such a change in use of the land as will permit a modification of the basic institutional pattern of the community.

Since 1920 the Federal Government has made emergency crop and feed loans in 10 different years. Such loans have aggregated about $226,000,000. A significant percentage of these loans has gone either to farmers on land which was submarginal or to farmers operating small tracts under such a system of tenure and cropping as to prevent the families from earning an adequate livelihood.

Just how great a subsidy to occupancy of poor land or pauperizing tenure these loans have been cannot be determined without much further research. However, it is significant that positive measures are now under way to change the type of agriculture in the northwest dry-land farming area which was the sole recipient of these emergency loans in 1921 and 1922. This area shared with other areas the loans made since 1930.

A survey of county agent opinion in 1932 by a technical committee of the National Land Use Planning Committee indicated that something less than 20 percent of the borrowers of emergency crop and seed loans in 1931 and 1932 were farmers who were either farming land which should be retired or were persons who should have been in other occupations. This percentage can be taken as no more than a rough indicator; but it does suggest that although a predominant part of the loans

FIGURE 48.—A farm home in the hill country of northern Georgia. This cabin of squared logs and shake roof, lacking all save the most primitive conveniences, is typical of wide areas in the Appalachians. In such districts, the total gross family income usually does not exceed $300 annually, and 50 cents is considered a good daily wage.

were not granted to submarginal areas, a very appreciable number of them were so made. There has been a high rate of loss on these emergency loans, particularly those extended in earlier years.

The mortgage indebtedness of submarginal areas represents a comparatively small part of the total volume of such outstanding credit for the country. In areas that are characterized by a self-sufficing type of agriculture, the inclination to contract mortgage indebtedness is not strong, either on the part of borrowers or of lenders. Extensive areas of submarginal land, however, are devoted to commercial types of farming. In such areas there is a tendency to incur excessive indebtedness during temporary times of good prices. The volume of such debt fluctuates widely between periods of prosperity and depression. The characteristic course of development during periods of rising prices is that of a growing percentage of properties mortgaged and a rapidly accumulating volume of debt until the proportion of total value represented by indebtedness results in narrow equities by owners. A collapse of prices discloses a general absence of reserves and is quickly followed by wholesale delinquencies, foreclosures, and surrender of titles because of debt pressure. Within a few years the proportion of owner-operated farms may become greatly reduced as vast tracts of land are foreclosed and much of it is abandoned. Such submarginal areas are typically far from market, and, since transportation costs are relatively constant, farm incomes and value of land are reflected in extreme fluctuations.

Behavior of this course of events, as illustrated by certain parts of the wheat plains of the West and of the cotton-growing lands of the Southeast and other territories in which temporary periods of high prices

have induced unduly expanded production and increase of equipment, indicates that the first point of attack for remedial measures should be directed to that part of the cycle at which indebtedness begins to accumulate. The conditions under which credit is extended should outline underlying requirements that will restrain settlement by those not prepared for such work and which will give reasonable assurance that those who become settlers will be able to carry on through periods of distress without threatening the collapse of credit arrangements and the enterprise that has been launched. Observation will indicate that unless the conditions governing the extension and amortization of credit in characteristically submarginal areas are determined in periods of declining or stable prices, there is small likelihood that the necessary credit restraints will be imposed afterward, when prices have risen and the economic activity of the area is caught in an upward surge of prosperity.

Efforts to withdraw submarginal land from agricul tural use or to obtain sufficient control to govern the character of its use may encounter existing indebtedness which must be dealt with before control becomes possible. Under such circumstances it may frequently be necessary to work out debt adjustments with creditors which will permit purchase of the land at its reasonable market value.

Number of Farms, Uses, and Value of Real Estate which it is Proposed to Retire from Arable Farming: As previously noted, there are 454,000 farms which it is proposed to retire from arable farming. There are a total of 75,345,000 acres in these farms. Of this land, 20,163,000 acres, or 27 percent, is crop land; 34,883,000 acres, or 47 percent, is pasture land; 20,298,000 acres are "other land" in farms—woodland, farmsteads, etc. The total value of these farms is estimated to be $682,909,000.

The distribution of this acreage by regions is given in table 20. Of the 20,163,000 acres of the crop land on these farms, 1,659,000 acres were in harvested crops in 1929, and 3,566,000 acres, or 17 percent, were idle. The important crops produced on this land were hay, 4,650,000 acres; corn, 3,369,000 acres; wheat, 3,917,000 acres; and cotton, 1,611,000 acres. (See table 21.)

The total value of production on these farms was $203,610,000 in 1929. This includes products consumed by the family as well as those sold or traded

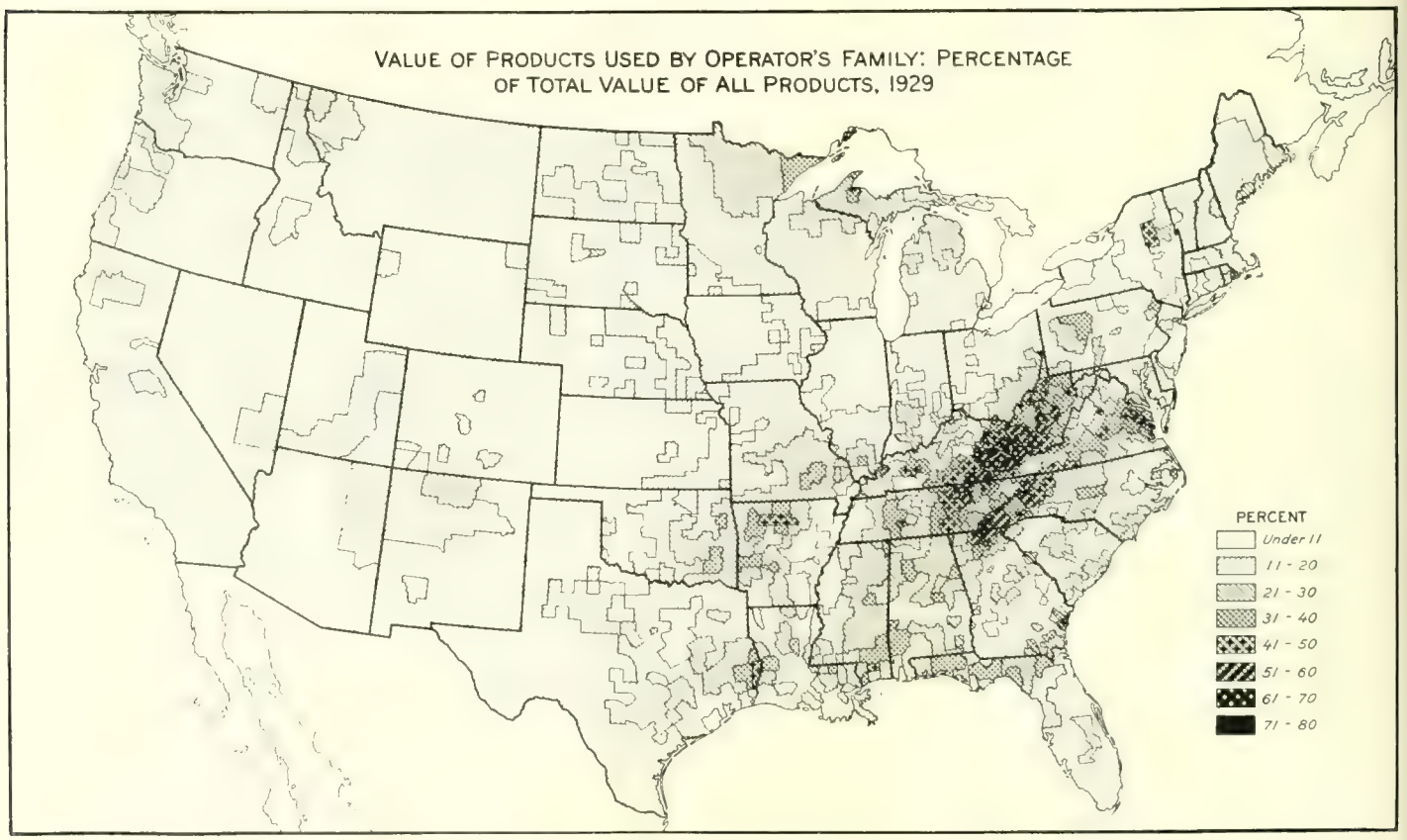


FIGURE 49.—Commercial agriculture is characteristic of practically all parts of the United States, except the Southern Appalachians. In several counties of eastern Kentucky only about one-fourth of the products of the farms, measured by value, were sold in 1929, according to the census. On the other hand, in most of the States westward and southwestward from Iowa, also in northern and central Illinois, parts of Indiana, Ohio, New York, and Massachusetts, and in nearly all New Jersey, over 90 percent of the products of the farms were sold. These figures are heavily weighted by the larger farms, which sell nearly all their products. However, in all the United States in 1929 there were only 500,000 "self-sufficing" farms, that is, farms on which more than half the products were used by the farm family. This is about 8 percent of all farms, excluding the 340,000 part-time farms, many of which are also self-sufficing.

TABLE 20.—*Number and area of farms, acreage of crop land, pasture, and other land, and value of real estate on farms proposed to be retired from arable farming*

Region	Number farms	Total acres	Acres crop land	Acres pasture	Acres woodland, farmsteads, etc.	Estimated value, real estate as of 1934
1. Northeastern highlands	50,300	6,534,500	1,658,300	1,909,500	2,966,700	$108,176,000
2. Southern highlands and their margins	125,500	9,085,700	1,815,200	2,404,800	4,865,700	90,857,000
3. Southeastern hilly cotton and tobacco	122,700	10,368,000	2,957,000	874,100	6,536,900	62,208,000
4. Great Lakes cut-over	27,500	3,437,500	1,100,000	550,000	1,787,500	51,563,000
5. Atlantic and Gulf coast cut-over	30,500	1,828,100	548,400	274,200	1,005,500	9,141,000
6. Pacific forest and cut-over	13,300	3,039,000	332,700	1,702,600	1,003,700	24,312,000
7. Western Great Plains	26,000	28,365,900	7,306,700	20,739,400	319,800	170,195,000
8. California valleys and foothills	9,500	3,203,000	698,700	2,369,200	135,100	64,060,000
9. Columbia Basin	2,800	3,244,000	1,543,000	1,604,400	96,600	32,440,000
10. Arid grazing and irrigated	7,300	2,512,400	728,800	1,472,500	311,100	10,050,600
11 and 12. Northeast and central agricultural	15,400	1,634,300	666,100	460,300	507,900	32,686,000
14 and 15. Gulf coast prairie and Mississippi Delta	16,600	1,431,600	509,800	493,600	428,200	21,474,000
16. Middle coastal plain	6,800	661,200	298,700	28,900	333,600	4,628,000
Total	454,200	75,345,200	20,163,400	34,883,500	20,298,300	682,090,000

TABLE 21.—*Retirement farm data*

[In thousands]

Region	Farms to retire		Crops to retire											
	Number	Harvested acres	Hay	Wheat	Corn	Oats	Barley	Rye	Cotton	Tobacco	Potato	Sweetpotato	Buckwheat	Flax
Northeastern highlands	50.3	1,409.5	1,053.0	21.6	98.0	132.6	6.0	6.5			31.7		37.2	
Southern highlands and margins	125.5	1,397.7	365.0	32.6	604.0	94.1		3.7	177.0	3.8	16.3	7.5		
Southeastern hilly cotton and tobacco	122.7	2,365.6	179.2	63.8	876.0	71.2		2.5	938.2	45.4	6.1	36.9		
Great Lakes cut-over	27.5	972.4	544.2	31.2	108.3	153.7	31.4	24.4			43.3			
Atlantic and Gulf coast cut-over	30.5	466.1	14.6		161.6	2.5			236.0	2.5	1.5	11.0		
Pacific forest and cut-over	13.3	273.9	163.7	31.0	3.7	18.0	5.7				2.1			
Western Great Plains	26.0	6,546.8	1,571.0	2,852.0	1,048.0	424.0	348.5	26.8			13.8			343.2
California valleys and foothills	9.5	524.0	131.4	43.0	8.2	13.0	77.5				1.1			
Columbia Basin	2.8	776.2	105.8	617.5	1.0	3.6	10.3				1.5			
Arid grazing and irrigated	7.3	536.4	268.5	195.1	13.1	12.6	19.0				5.6			
Northeast and central agricultural	15.4	603.7	193.0	29.4	203.2	77.4	3.7	3.0	2.0	.4	5.5			
Gulf coast prairie and Mississippi Delta	16.6	441.0	34.9		135.8	15.4			171.3		3.3	14.1		
Coastal plains	6.8	277.1	26.2		108.3	2.3			86.6	6.6	.3	2.7		
United States	454.2	16,590.4	4,650.4	3,917.2	3,369.1	1,020.1	502.0	66.9	1,611.1	58.5	132.1	72.1	37.2	343.2
Percent United States total 1929 for each item	7.2	4.6	6.9	6.3	3.4	2.8	3.9	2.2	3.7	3.2	4.4	11.1	6.0	11.6
Percent harvested acreage on retirement farms			28.1	23.6	20.3	6.2	3.0	.4	9.3	.4	.8	.4	.2	2.1

A very large proportion of this—45 percent was consumed on the farm and 55 percent was commercial production. These percentages may be compared with 13 and 87, respectively, for all farms in the United States, and show that these farms in poor farming areas are much less commercial than are the other farms of the country. (See fig. 49.) There are three regions where the farms are more commercial than in the other regions—in the Great Plains, the Columbia Basin, the Cotton Belt, and the semiarid grazing and irrigated region of the interior basin. In these regions, 75 percent, 80 percent, and 73 percent, respectively, of the productions were commercial production.

Program for Retirement of Submarginal Farm Lands: The demonstrational program for the retirement of poor farm lands from cultivation came into existence in the fall of 1933 as a result of a number of considerations: (1) The growing realization that in certain areas Government action is necessary to stay the long continued decline of rural civilization; (2) recognition of the need for making a substantial beginning in the task of developing more constructive modes of land use in the extensive agricultural areas now characterized by pathological modes of use; (3) the need of substituting a constructive rehabilitation program for the present increasingly expensive relief program in these areas; and (4) the desirability of retiring poor farm lands in proportion to the new lands being prepared for cultivation by Public Works Administration funds allocated to reclamation projects. The Public Works Administration allocated the sum of $25,000,000 to the Surplus Relief Corporation for the land retirement program, the administration of which was placed in the hands of a submarginal land committee.

This sum was subsequently increased by $12,500,000 of drought relief funds which are to be used for the purchase of submarginal land in the drought-stricken area.

The advocates of the land retirement program visualized the new program as the beginning of a long-time plan to readjust our land use pattern to yield its highest social and economic benefits and to aid in the rehabilitation of hundreds of thousands of rural families who are victims of maladjustments. It was determined, therefore, to employ the present funds to purchase land in each of these sections of the major problem areas where distress is most serious, with a view to devoting the land thus acquired to its highest social and economic use and aiding the families to remove to locations where they can have better opportunities.

Purchase areas, the highest social and economic use of which is grazing, forestry, soil erosion control, agricultural experiments, or big-game refuges, are to be selected and planned by the Land Policy Section, Division of Program Planning, of the Agricultural Adjustment Administration; areas best suited for recreational purposes, by the National Park Service; areas suitable for migratory waterfowl refuges, by the Biological Survey; and areas intermingled with or adjacent to existing Indian reservations needed to restore the Indians to independent agricultural self-sufficiency, by the Indian Bureau. The selections of land for purchase are subject to approval by the Federal Relief Administrator, who is charged with fiscal responsibility for the programs. The regional directors of the Land Policy Section are also employed by the Emergency Relief Administration as its field representatives and have general responsibility for all four phases of the program.

The present funds have been tentatively allocated among the types of projects to be developed by these four agencies as follows:

Section	$25,000,000 Public Works Administration grant	$12,500,000 drought relief fund
Land Policy Section	$15,000,000	
National Park Service	5,000,000	
Indian Service	2,500,000	
Biological Survey	1,500,000	$3,500,000

The Rural Rehabilitation Division of the Federal Emergency Relief Administration is responsible for the resettlement of families now living in the areas to be acquired.

Land acquired in the so-called agricultural projects is to be used for Federal or State forests or parks or for State or Federal upland game refuges, or a combination of such uses, in accordance with the needs of the locality. If located near a federally administered forest or park, the new land will be attached to the existing administrative unit. Otherwise it is probable that it will be leased to the State to be administered as State forests, parks, or game refuges, subject to certain specified conditions for the protection, development, and use of the land. The recreational fund is being employed to establish a large number of comparatively small vacational units in the general vicinity of large industrial centers and for the recreational use of families who cannot go long distances for outdoor recreation The wildlife funds are devoted to the establishment of a series of flyway refuges along the principal lines of migration of waterfowl. The Indian funds are to facilitate much needed additions to Indian reservations.

An important feature of the program is the rehabilitation of the present occupants of the purchase areas now living a socially degraded existence as a result of their inadequate income, poor schools and roads, and infrequent contacts with an outside civilization. It is planned to give these people an opportunity to reconstruct their lives on a firmer and better basis. It is recognized that some of these families to be removed from the purchase area are not capable of again assuming responsibility for farm management and will need some supervision and perhaps aid, either because of age and infirmities or because they are not now and never were able to cope with all the complex problems which a farmer must be prepared to face. Such people will be aided in developing small subsistence homesteads, the returns from which may be supplemented by part-time work in nearby forests, parks, or grazing districts, on farms operated by more capable individuals, or in nearby industries which may be introduced.

Other families will be assisted in developing farms outside the purchase area. The Government plans, as part of the submarginal land program, to investigate, select, and purchase areas on which these people can be resettled with the surety of a higher standard of living. In most of the present submarginal land projects it has been found that there are lands in the vicinity of the purchase area much superior to the farms which are being purchased and which may, with the expenditure of some capital for irrigation, ditching, or clearing, be made into successful farms. The Government is purchasing these resettlement areas and will sell or lease them to the farmers on long-term credits. The Government will also aid the farmers in developing their farms and in equipping and stocking them. To carry out this work quasi-public corporations are being formed to which the resettlement lands will be transferred, and funds for their improvement will be made available by the Federal Emergency Relief Administration.

The most recent report (Nov. 10, 1934) of the status of the program indicates that the number of projects in various stages of development are: 48 Indian projects, 36 recreational, 25 migratory waterfowl, and 58 agricultural demonstration projects. The total area included is 7,693,552 acres, and the area under option, 2,097,884 acres. The average option price is $5.00 per acre, which is higher than will be paid in actual purchases. Considering the fact that the land purchased consists of farms and improvements, the average price compares favorably with the average paid by the United States Forest Service in the acquisition of forest acreage.

The present submarginal land policy was undertaken as a demonstrational program upon which, if it were deemed successful, a thorough-going long-time plan for the readjustment of our land use pattern to its highest economic and social values and the rehabilitation of the great number of socially backward residents of such areas might be projected. Attainment of the broad objectives of the program in terms of conservation and rehabilitation appears to be assured.

The present land program is, then, a broadly planned, well-defined program to demonstrate the possibilities in removing existing maladjustments in poor farming areas and restoring their occupants to a higher social and economic position.

Recommendations for Continuance of Program: It is recommended that the program be continued for a period of 15 years, with a view of acquiring 5 million acres of farm land each year, which would involve the annual removal of about 1¼ million acres from cultivation. This would cost, at prices at present being paid for such land, about $25,000,000 a year. The land now being purchased, however, is the poorest. The average value of the 75 million acres of land recommended for retirement is estimated at about $9 per acre. If such values persist, the average annual cost of the retirement program for the 15 years would be about $45,000,000.

Suggested Changes in Procedure of Submarginal Land Program: Certain changes, however, should be made in procedure and in the general set-up of the program as follows:

1. The primary aims of the submarginal land program are to rehabilitate the socially backward residents of problem areas and to put the land to its best use. To select submarginal land for recreational purposes, Indian settlements, or wildlife refuges is to subordinate the land program to other purposes, desirable in themselves but difficult to reconcile with the primary objectives of the submarginal land program. It will frequently be true that submarginal land will also serve these other purposes, but lands most desired for these purposes are not always those which best subserve the objectives of the submarginal land program. Such funds as it is desired to devote to the several purposes should be separately allotted so as to avoid the hampering necessity of trying to reconcile quite distinct objectives.

2. Lands acquired by Federal funds should be in general retained by the Federal Government. For administration they should be assigned to the State or Federal agency best suited to care for and develop them.

3. The submarginal land program should not be pushed too rapidly by placing time limits before which existing appropriations must be spent. Extreme caution is necessary to avoid making costly errors which might endanger the success of the program. Furthermore, it is difficult to acquire land at suitable prices when reluctant sellers must be hurried into selling in order to complete the blocking up of an area within a limited time. It is best to wait until the more reluctant sellers are ready to dispose of these lands.

4. The process of removing settlers from a problem area should not be pushed so rapidly as to compel the making of inadequate plans for resettlement. Success of the program does not require the immediate removal of all settlers.

5. The administration of resettlement should be provided through local quasi-public corporations, especially developed for the purpose and having adequate representation from the State experiment stations and extension services, as well as from the Federal agency responsible for the land settlement and the agricultural land administration of the Department of Agriculture.

6. As a general policy families should not be removed to distant communities or beyond State lines, although exceptions to this rule in particular cases may be desirable.

7. Financing of resettlement should be made part of a general policy of settlement without the cramping limitations resulting from dependence upon relief funds, with the special restrictions attendant upon their expenditure. Funds should be available to facilitate the resettlement of families not on relief.

The necessity of providing for the resettlement of families living on submarginal land will be very much reduced when industrial recovery and fuller industrial employment develop. Then a large proportion of these people will find their own place in the economic system. It is probable, however, that there will always be some families who wish to remain on the land and who should be aided in one way or another to achieve proper relocation either through guidance and direction or through such credit policies as the Federal Government may develop for the purpose of aiding would-be farmers to acquire the necessary land and equipment.

8. The Federal Government should aid in the restoration of worn-out or badly eroded lands which are transferred to State administration, through such agencies as may best serve the purpose. The Federal Government should also cooperate in providing adequate fire protection. While the States may be willing to assume the burden of administration they are frequently not in position to restore the wrecked lands to normal condition.

Measures, Other Than Public Acquisition, for Discouraging Settlement of Lands Contrary to General Welfare [4]

Statement of the Problem: To enter upon a policy of removing poor farm land from cultivation while leaving the door open to the further settlement or resettlement of such lands is obviously futile. The very conditions that emphasize the need for the policy of withdrawal of land from agricultural occupancy will be reproduced in other areas. Indeed, even within the areas where the removal of widely scattered families is undertaken, it is desirable to prevent the settlement of intervening areas of poor land which it is not advisable to purchase.

The farm land market is overloaded with undeveloped land potentially available for farming. Under present conditions, however, only a relatively small proportion of such land appears to offer possibilities for profitable agricultural development. The huge waste of human and economic resources which has resulted from repeated attempts to farm land of poor agricultural quality calls seriously in question the wisdom of a laissez faire policy which permits inferior land to be settled in response to the desires of interested promoters and local "booster" interests, without regard to the capacity of the land to sustain a stable and profitable agriculture and long-time requirements for expansion of the agricultural acreage. There is a legitimate public concern in keeping settlers out of areas where they cannot make a living and consequently will require recurrent provision for public relief; in discouraging sparse settlement in the interest of social welfare and economy of governmental costs; and, finally, in preventing overexpansion of the cultivated area, to facilitate the adjustment of farm production to demand.

Since the passing of the frontier and the disappearance of large areas of good, free lands, there has been less and less of self-direction in the movement of settlers to the land. The direction of the movement has been determined in large measure by the efforts of interested land promoters, seeking to profit by the land hunger of would-be settlers or creating such land hunger by skillful salesmanship. Owners of idle lands are driven to make strenuous efforts to dispose of their holdings by the constantly increasing burden of carrying charges. Their efforts and those of professional land promoters have been powerfully reinforced by State immigration bureaus, railroad companies, and local business interests which profit directly or indirectly from the sale and settlement of land. Local development associations, "booster" clubs, and banking and transportation interests very naturally have labored zealously to increase the population of their particular localities and thereby to enhance land values. As a result of these activities the landward movement of the past 20 years has been largely artificial, and frequently carried out without regard to the interests of the settlers themselves or to the national or local welfare.

The problems presented by this artificially stimulated land settlement movement are particularly acute in the cut-over regions of the South, the Great Lakes States, and the Pacific Northwest, where most of the land is held in large blocks by lumber companies and land companies, which seek to escape burdensome carrying charges through settling their holdings; in partially abandoned farm areas of the Eastern States, where populations are maintained, uneconomic production continued, and the natural process of abandonment retarded by a constant influx of new settlers; and in the semizrid grazing lands of the West, particularly the western fringe of the Great Plains lying immediately east of the Rocky Mountains, where range lands are subdivided for settlement in periods of good rainfall and high prices.

Importance of Withdrawing Federal Lands from Homestead Entry: The Federal Government itself has been mainly responsible for permitting the unwarranted settlement of range areas. Homesteading upon semiarid land ill-adapted to ordinary farming has been under way in the far western States since the turn of the century, when the humid portions of the public domain were becoming exhausted. The enactment of the Enlarged Homestead Act of 1909 and the Stock-Raising Homestead Act of 1916 sustained and increased this movement by enlarging the amount of land which could be entered to 320 and 640 acres, respectively.

The lands being entered were progressively poorer each year and naturally the percentage of failures was high. Between 40 and 60 percent of these homestead entries have been relinquished or canceled and many more homesteads have been abandoned after the claims were perfected. In Idaho, Utah, Montana, Washington, California, Colorado, and Oregon entire areas have been abandoned by once optimistic homesteaders who

[4] The following persons have contributed to the preparation of this section: Davis McEntire and Paul W. Gates, Land Policy Section, Agricultural Adjustment Administration; C. I. Hendrickson, Division of Land Economics, Bureau of Agricultural Economics; David L. Wickens, Division of Agricultural Finance, Bureau of Agricultural Economics; and L. F. Kneipp, Forest Service.

spent their all in attempting to develop farms, only to find that a living could not be wrung from land where the rainfall was inadequate and the soil poor in quality.

Nothing short of complete withdrawal of all the land from entry or repeal of the homestead and selection laws will put a stop to the continued homesteading upon land unsuited for agriculture and upon which many settlers are likely to be financially ruined or become subjects for relief. The need for prompt action is emphasized by the fact that there were 7,741 original entries during the year ending June 30, 1934, and the number is keeping up well during the current year.*

It is obviously an amazing inconsistency to spend millions in aiding misguided settlers to escape from impossible conditions while encouraging them through another policy to hazard their efforts and material resources on lands where there is no apparent chance of making a livelihood. (The broader problem of the public domain is discussed below.)

Discouragement of Settlement on Unsuitable Areas in State Ownership: Somewhat analogous to the problem of Federal public domain is that of State-owned lands which are subject to settlement more or less indiscriminately, with little reference to their adaptability to farming. In the western States these areas were acquired by donation from the Federal Government and are now open to sale or lease. In the majority of States tax delinquency laws provide for the sale of reverted lands or permit them to be homesteaded. As a problem of land use this is discussed more fully below, but it is mentioned here because of its bearing on unwise land settlement.

Cooperative Federal-State Delimitation of Areas Unsuited to Settlement: It seems clear that the essential basis of any adequate public program for the direction of land settlement, whether on publicly owned or privately owned lands, is a clear determination of the areas in which settlement should be discouraged. This would be an essential element in the proposal outlined elsewhere in this report for a cooperative Federal-State land planning program with particular reference to outlining problem areas.

A definition of areas unsuited for settlement or within which settlement is contrary to public policy would in itself help to discourage settlement in such areas. Both settlement agencies and settlers would be disinclined to undertake settlement operations in the face of such governmental action. This would be especially true if the definition of areas unsuited for settlement were supplemented by a strong publicity policy to make the public acquainted with the location and character of such areas. The large number of settlers who have located on land physically or economically too poor to admit of profitable farming is evidence that the average settler does not possess the necessary knowledge or judgment to select the right combinations of soil, climate, and location, and to steer clear of the ruinous combinations of these elements. It should be a function of the State to provide him with the information he needs.

It seems doubtful, however, if land classification and publicity alone would be sufficient to cope with the conditions of oversupply and intense competition to which the land-selling business is subject. It is desirable, therefore, to consider additional measures to insure conformity to the classifications set up.

State and Local Zoning: One type of measure is State and local zoning. Zoning is a restriction on private property in land exercised under the police power. It has become a recognized tool in giving effect to city plans. Although its use in rural land use planning has only begun, it is probable that it will ultimately become just as effective a tool in that field as it has in city planning.

It is one means of influencing the development of rural areas, especially those in process of changing from more extensive uses, such as forestry or grazing, to agriculture and those changing from agriculture to the more intensive urban uses. It offers a means of preventing the evils of scattered settlement in the one and of "ribbon" development in the other—in short, of directing land to its highest and best use and preventing it from being employed in purposes for which it is not suited, or which are contrary to general welfare. We should not expect too much of rural zoning, however, as an immediate instrument for bringing about a widespread improvement in land utilization. Zoning in rural areas is a novel procedure. It has not yet become widely accepted by public opinion, nor should it be regarded as a cure-all for all rural land use problems. Every step from the framing of the enabling act to the enactment of the actual zoning ordinance should be thoroughly and carefully worked out, and the support

* For recent action to withdraw public domain from entry, see p. 204.

FIGURE 50.—A not uncommon type of farm home in the Great Lakes cut-over region. All too frequently settlers have been induced to occupy land of such low productivity that to provide the barest family living is impossible. Caring for this family is a social burden which might have been avoided by proper public regulation of land settlement.

of the public of the State and locality concerned secured.

By permitting agriculture on the land best suited to farming and restricting it on other land, the zoning of rural land in areas where agriculture is developing promotes more compact settlement than usually occurs in such areas. This makes for economy of local government, especially in expenditures for roads and schools. This is the objective of rural zoning which makes the greatest appeal, but zoning will bring other desirable results. The more compact settlement provides a fuller community life, which is especially important to the women and children. The prevention of isolated settlement in districts dedicated to forestry and recreation will reduce fire hazards, poaching, and other conditions and practices destructive of the natural resources of such districts. It will also prevent the low plane of living and the burden of relief which result from the attempts to farm land of low economic productivity.

Zoning as a restriction on private property in land may take away some of the value of the land. It is probable that if a zoning restriction should seriously impair the value of property it would not be held reasonable unless public welfare demanded such a restriction. Such restrictions on private property in land in the urban field have been upheld as constitutional by State courts and by the United States Supreme Court. If every step is carefully considered, it should be possible to adopt ordinances in rural areas that will be upheld when tested in the courts.

In urban zoning ordinances two provisions are frequently included which are aimed at making the regulations reasonable. One is the exemption of all established uses which may not conform to the proposed uses, and the other is the establishment of boards of adjustment to review administrative decisions. The second of these provisions may well be included in all rural zoning ordinances and it will probably be wise, within limits, to exempt established uses.

Rural zoning, to be most effective, should be a cooperative undertaking between the State and the county or other local administrative unit. The necessary enabling act has to be passed by the State legislature, but the drafting and enactment of the zoning ordinance itself should be left to the county board or other local legislative body. It is probable that the most effective zone plans can be secured only if experts are active in developing them, and for this reason the State should require the use of technical assistance in formulating plans. It is even more certain that the effective enforcement of the ordinance can be secured only with the active cooperation of the public of the locality affected. It is highly desirable, therefore, if not absolutely essential, that the enactment of the ordinance be the function of the local government.

FIGURE 51.—An abandoned farmstead in eastern Oregon. This is typical of many dry-farming areas in the Columbia Basin and the arid grazing and irrigation region, where misguided settlers have lost or are in process of losing their all in an unequal struggle with the natural environment. Zoning of such land for extensive grazing would avoid repetition of this kind of tragedy.

That zoning may be used effectively in rural land use planning, the public must be educated to the need for such zoning and the advantages to be gained by its use. To attempt to pass zoning enabling acts before this has been done will probably lead to their defeat on account of the impression that rural zoning is unconstitutional or on the argument of regimentation, etc. With the support of public opinion an enabling act should be passed to enable counties to zone lands for agriculture, forestry, recreation, and other uses. After the enactment of such an enabling statute, some State agency charged with the development of zone plans should be ready to offer its assistance to any county or local authority in the preparation of a suitable ordinance. Agricultural colleges, county agricultural agents, and others interested in land use planning in a particular State can render valuable service by bringing to the attention of the public in any county in which zoning may be effective the benefits which the county might secure from the enactment of such an ordinance. After the backing of the influential public opinion in the county has been secured, a zoning plan should be developed and a zoning ordinance prepared by technical men from some State agency designated for that purpose, preferably in the enabling act, in cooperation with a local committee.

The role of the Federal Government in a program of zoning is limited to encouraging and assisting State and local authorities in employing zoning as an effective implement in directing land into its best use. An essential basis is the cooperative Federal-State classification of land for the purpose of delimiting problem areas. It is imperative that any zoning ordinances adopted should be based upon adequate information and knowledge concerning present and probable future uses of the land in each use district. A zoning ordinance can be

most effective in directing land use only if it is based upon facts. Likewise, the only way in which the courts can determine the reasonableness of a zoning ordinance is upon the facts presented. In the building of this foundation the Federal Government not only could, but should, take an active part. The Federal Government might also provide technical assistance in the preparation of zoning plans and in drawing up zoning ordinances

It will be the part of wisdom in drafting the earlier rural zoning ordinances to proceed cautiously, zoning out of agricultural use only such land as is unmistakably nonagricultural. It is to be noted, however, that zoning does offer a workable method of preventing scattered settlement and heavy costs for schools and roads. Nevertheless, in order to establish precedents, it is well to make the early ordinances such that they will almost certainly be upheld. As in urban planning, it is probable that zoning in rural areas will be a process of gradual development. The precedents established in the urban field should make this development easier and enable it to proceed faster than otherwise would be the case. Zoning should be supplemented by other measures which aid the owner within a restricted zone to use his property in line with restrictions imposed upon it. These include, among other things: (1) Reduction of tax assessment on land within restricted zones; (2) a forest crop law or equivalent; and (3) provision whereby private owners within restricted zones could exchange their holdings, if desired, for State or locally owned lands in the unrestricted zone.

Zoning should not be considered, however, as the sole means of implementing a land use plan. It should be coordinated with the other measures designed to bring about better land use. All the measures applicable to a land use plan should be made to complement each other. Zoning can be an effective complement to these other measures, such as land classification and the associated extension and publicity program; the measures outlined above for preventing soil depletion; the forestry, wildlife, and recreational programs; the programs for tax delinquent land and land retirement; and the other measures mentioned herein for the control of land settlement.

Possible Purchase of a Permanent Right to Exclude Settlement: It has sometimes been suggested that instead of zoning, or as a complement to zoning, the Federal Government, preferably with the consent of State or local governments, enter into long-time contracts with private owners of land, conferring the right to exclude unwarranted settlement from the areas to which the contracts would apply. Whereas zoning is an exercise of the police power to compel exclusion, such contracts would compensate the property owner whose interests were injuriously affected. Covenants of this nature have the further advantage that they might constitutionally be entered into by the Federal Government, whereas zoning under the police power is a function exclusively of the States.

Public servitudes upon private lands in the form of restrictions upon land use have frequently been employed as a means for achieving certain public purposes. One common form is a right of view under which the landowner yields his power to impair the scenic qualities of land abutting on a public highway. The Federal Government has entered into contracts permitting it to flood lands at certain intervals. The possible use of similar contracts was suggested above as a means of controlling soil depletion in certain areas.

As an instrument for preventing settlement of unoccupied land of low agricultural quality, however, long-time contracts appear to have distinctly limited possibilities. They would take the form of restrictive covenants attaching to the land, stipulating that the land could not be occupied for farming. The cost of a servitude of this character would vary directly with the degree of the owner's desire to develop or sell his land for agricultural purposes.

In view of the fact that vast areas of idle land are being pushed onto the farm land market by owners eager to dispose of their holdings to settlers and escape the burden of carrying charges, it is difficult to see how such servitudes could be placed on the land at a cost much less than the price of the land itself. The large owners of idle lands are in most cases not developing their properties but holding them with a view to selling to settlers. From the point of view of such speculative holders such contracts would largely destroy the value of the land and would have to be paid for accordingly. The same considerations apply to owners of abandoned or to-be-abandoned farms.

As regards undeveloped land held *bona fide* for nonagricultural purposes, the owners thereof would doubtless be willing to sign away their agricultural rights for a slight consideration. But in that case it would seem to be a waste of public funds to spend money for contracts to keep settlers out when apparently no settlers were likely to come in.

The usefulness of long-time contracts for the purpose here discussed would appear to be further limited by the lack of definite standards for computing the fair value of such contracts, and by the probability that owners of forest, mineral, grazing, and other types of nonagricultural land, not desiring to settle their holdings, would nevertheless be stimulated to develop artificial settlement in order to persuade the Government to purchase their agricultural rights in the land. Such abuses might lead to an outright waste of public funds.

There is reason to believe, however, that within a limited sphere the acquisition of such contracts could be made a useful adjunct of a land settlement policy. They might be advantageously employed, for example, in withholding an unoccupied area from settlement, not because of inherent submarginality of the land for agriculture, but for the purpose of promoting orderly and compact settlement along established roads or near settled communities. In such cases it is conceivable that private owners might be willing to agree not to settle their lands for a period of years for a consideration approximately equivalent to the sum total of taxes over the life of the contract. This might not be true if other carrying charges were high or if the landholder were particularly eager to dispose of his holdings.

Control of Settlement Through Credit and Relief Policies: If certain areas are worked out where it is public policy to exclude further settlement, considerable pressure to prevent unwarranted settlement in such areas could be exerted through a definite announcement that neither public credit nor relief funds would be made available to persons who settled in such areas contrary to established public policy. This alone would not deter all persons or agencies from undertaking settlement in such areas, but it would exert a considerable influence. Credit control as a means of preventing unwise settlement might be peculiarly effective in marginal areas because such regions are generally capital-deficit territories and those who undertake to operate farms are in most cases largely dependent upon borrowed capital.

It is shown elsewhere that both Federal seed loans and relief expenditures are heavy in certain areas of doubtful suitability for agricultural occupancy. Now that people have settled in such areas, they should have access to such relief loans or contributions as their needs may justify, but certainly the Government should discourage the creation for itself of new obligations through unwarranted settlement in areas unsuited to agricultural occupancy.

Modifying State Policies with Respect to Grants-in-aid to Avoid Encouragement of Undesirable Land Settlement: Unquestionably the more liberal State policies of grants-in-aid of local schools and roads have encouraged both the original settlement and the continued occupancy of lands contrary to the general public interest. But any attempt at rectification of this anomaly must recognize the inherent and basic conflict between our State aid and our land settlement policies. Our land settlement policies and programs have told people to live wherever they, or the land agents, might choose; and "equal opportunity for all" has obliged us to bring schools and road facilities to them even at unreasonably high costs to the State through subventions.

The first step in liquidating this conflict is to decide in what places and under what conditions settlement is in the public interest. A necessary corollary is a classification of the land coupled with such devices for controlling land settlement as have been outlined above. The granting of State aids for schools and roads could be used as a supporting, though subordinate, instrument in the social direction of land settlement. Persons moving into areas not hitherto provided with schools and roads and lying within areas designated in the land program as nonagricultural should be warned that they will not be provided with such advantages. In order to prevent the children from growing up in ignorance, arrangements might be made to board them near established schools. Persons moving into areas zoned for nonsettlement but already partially occupied and provided with schools could be declared by law ineligible to receive any direct employment or remuneration from State aids for transporting children to school or for the maintenance of town or country highways. Such a policy would also have the merit of labeling relief cases unambiguously. There may be justification for a lenient policy toward isolated settlements already made, at least until the families can be provided for elsewhere; and the children should be educated. This obligation, however, should not extend to maintaining an improved road for all-year machine traffic.

As a corollary to these provisions it would also be desirable that officials responsible for the administration of State grants-in-aid be given greater administrative discretion than most of them now exercise. This discretion should be exercised, however, in conjunction with a definite land program, not merely as an arbitrary exercise of authority.

State Regulation of Land Settlement: From the standpoint of an adequate land program the public interest is primarily concerned with preventing the settlement of areas that should be devoted to other uses. The public is also interested in discouraging unscrupulous practices in the sale of agricultural land, whether or not it is suitable for occupancy or whether or not its settlement is consistent with public welfare. The sale of all kinds of land is frequently attended by misrepresentation, transfer of poor titles, and other serious abuses. While statutes defining and punishing frauds govern practices clearly fraudulent, there are many practices in the twilight zone between fraud and honest and fair dealing.

If the Nation is going to concern itself with developing a wholesome rural life, it is obviously inconsistent to permit fraudulent or near-fraudulent real estate concerns to prey upon the legitimate land hunger of the people and to justify this under the easy doctrine of "let the buyer beware."

Many States have undertaken to regulate the business by real estate license laws, which usually provide for a licensing agency authorized to refuse licenses to, or withdraw licenses from, those guilty of illegal practices. In few States, however, is the law stringent enough or the administration strong enough to eliminate any but the most serious abuses. In many States it would be desirable to amend existing laws in the following particulars: (1) To require a written qualification test covering the applicant's competency to transact the business of a real estate broker in such manner as to safeguard the interests of the public; (2) to require the applicant to post a bond sufficient to guarantee the fulfillment of his contracts; (3) to invest the administrative authority with power to consider the soundness of investments offered and the character of the land to be sold as evidence of the applicant's honesty and trustworthiness; and (4) to construe the term "dealer" or "broker" as including any person or firm engaged in selling land for another, or buying it on his own account for the purpose of reselling it for agricultural purposes.

Land certification: Transfers of land to settlers by concerns engaging in land settlement as a business should be subject to regulation, and the State might well make such transfers conditional upon a technical examination of the land by competent experts and public certification of the use to which it is best adapted.

Any land or colonization company contemplating the subdivision and sale of a large tract of land should be required by law to submit to an appropriate State authority a map of the project showing:

1. The location of the project, roads, and other transportation facilities.

2. The land as subdivided for sale with the selling price of each tract. The State authority should have on its staff or appoint competent experts who should make an examination of each tract and submit a report covering all characteristics, physical and economic, affecting the suitability of the land for agriculture at the prices quoted and in the units offered for sale. Copies of the map and the report of the experts should be filed with the State authority, the land company, and the register of deeds of the county in which the land is situated. They should be available for public inspection at all times and the law should require that map and report be shown in full to the person buying or contracting for land previous to the execution of the contract.

Landowners or their representatives engaged in selling land in isolated tracts should be required by law to list their offerings with the State authority. Each tract should then be examined, reported upon, and certified in the manner described above. The seller should be required to furnish a certificate to every purchaser and a copy should be appended to the warranty deed and filed with the register of deeds in the county in which the land is situated.

For obvious reasons the law should not apply to the following classes of land transactions: (1) Individual sales of farms by the owners thereof or by agents acting for the owners, when such sales are not being made in the course of repeated and successive transactions by such owners or their agents; (2) sales of land located within the limits of incorporated places; (3) sales or transfers of land to banks, trust companies, savings institutions, corporations, or brokers or dealers in land.

It is not suggested that the State attempt to guarantee the success of any settler on any particular tract of land. But with regard to any land development project, the existence or nonexistence of certain fundamental physical and economic characteristics of good agricultural land can be certified to and the prospective settler be put in possession of adequate facts upon which to make a competent judgment of his chances to succeed.

In the case of the sale within a State of lands for settlement purposes situated in other States, safeguards should be thrown around the buyer similar to those now provided for purchasers of securities, including adequate determination by the authorities in the State in which the buyer resides that the land is reasonably well adapted to the purpose for which it is sold.

If a joint Federal-State program with reference to what lands should or should not be settled has been developed, then the State real estate boards or other administrative agencies would presumably make their regulations and their application consistent with the program.

For the sake of administrative efficiency, all land settlement control enactments should be administered by a single body in each State.

Inasmuch as nearly 50 percent of the land-selling companies operate in interstate commerce, and in view of the constitutional inability of the States to regulate advertising in newspapers circulating in more than one State, Federal action through the postal service may be helpful in supplementing State regulations covering the sale of land for agricultural purposes. There should be close collaboration between the postal authorities and the Federal authorities responsible for the administration of agricultural land policies.

If adequate measures should be developed either by the States or by the Federal Government for officially determining the feasibility of our irrigation or drainage projects, this would contribute materially to the protection of would-be settlers on such projects. This policy is discussed elsewhere in the present report.

Responsibility of Our System of Agricultural Land Tenure for the Inefficient Use of Our Resources [5]

Factors Which Prevent the Full Realization of the Ideal of Wide-spread Ownership: As already noted, the ideal of American farm land tenure has been the widest possible diffusion of landed property in owner operation. To this end the policy of the Government was directed. It finally granted in fee simple a quarter section of land to anyone who would agree to make it his home. Self-interest of the owner, it was believed, would automatically secure for society as a whole the goods and services it needed. This ideal has not been fully realized for a number of reasons.

One of these is speculation in land. The speculator has been anathema since the beginning of settlement in colonial times and he was kept in mind in every land act. Land acts, in general, attempted to eliminate the individual who stood between the Government land office and the settler who eventually reclaimed the land and added to the taxable wealth of the community.

Speculation has been of several types: (1) Those speculators who merely purchased land in anticipation of demand, buying especially strategic sites and the better land, thereby forcing the settler to pay more than he would have paid at the land office; (2) land companies, colonization companies, and "developers" who often sold undesirable land at high prices to victims consigned to years of toil and suffering on soil of disappointing quality. Too often speculations of this kind were carried on under the protection of local and State governments anxious to bring in settlers to increase their population to create new wealth. The reaction of failures was fatal, not only to the settler, but to the community itself; and (3) "mass speculation", caused by a mass optimism with respect to farm prices and land values. The Iowa land boom and Florida orgy of speculation were of this type, although in the case of the latter there was a great deal of promotion. The American psychology of easy wealth is one of the fundamental causes of this type of land speculation, aside from the intangibles of mass psychology and shifting events upon which false hopes may be erected. The absence of any resistance in law or custom to the free bartering of land has permitted speculation to go on unchecked.

The first type of speculation disappeared largely, though by no means entirely, when the Homestead Act was passed. The second type can be controlled by public certification of land development projects, the licensing of land dealers, and other regulations discussed elsewhere in this report. To discourage the third type, taxation of the second and subsequent transfers of land within a 12-month period might be used. Also, those Government credit agencies dealing with agricultural land should use their influence to discourage the too rapid transfer of land and exercise some control over the tendency for land to skyrocket beyond a legitimate level of values.

Inadequate or Inefficient Land Use:—The evil of mass speculation tends to produce instability in land tenure which tends to reduce the owner's interest in the land. He thinks principally of resale and the money to be made, and not of the land. The evil of mass speculation, resulting in a high level of prices, means that the purchaser often sinks the most of his money in land, leaving him inadequate resources for his capital equipment. This may be the case where land speculation has not inflated values. Sometimes a tenant makes the transition to ownership before he has adequate capital to finance both land and equipment. In other cases the area acquired may be too large for the managerial ability of the operator. The result is that production falls far short of the potential capacity of the land.

The tendency to overburden the farm with debt at the time of purchase means a reduction in the standard of living and a struggle for a number of years to meet interest and taxes. Under normal conditions before the Great War the years of struggle were compensated by easier conditions later and the increase in the value of the land which is realized when the farmer retires. However, with a fall in values instead of a rise the ratio of debt to value is increased instead of diminished and in some cases the mortgage exceeds the value of the land. The inflating of values during the war is largely responsible for the present situation with its distress and foreclosures. However, curbing speculation does not necessarily remove the discrepancy between mortgages and values, or between interest rates and farm incomes. The Farm Credit Administration is in a position to exercise leadership in a credit policy which will help to keep mortgage debt in line with true land values and make adjustments of interest and principal on the basis of indexes of farm prices and actual land values.

Thus in years of high prices, or favorable price-cost relationship in a given area as determined by present indexes or indexes especially prepared, the payment called for in that area would be subject to an automatic upward adjustment with the excess over the base rate of interest applied to principal. In years of low prices or unfavorable price-cost relationship the same adjustment would automatically reduce the payment to be made, the reduction to come first from the payment on principal, and thereafter from interest with the unpaid interest added to the unpaid balance of principal. It is believed that if the success of such a plan

[5] The following persons have contributed material which has been utilized in the preparation of this section: H. A. Turner, Division of Land Economics, Bureau of Agricultural Economics; David L. Wickens, Division of Agricultural Finance, Bureau of Agricultural Economics; J. K. Galbraith and Kenneth H. Parsons, Land Policy Section, Agricultural Adjustment Administration; and George S. Wehrwein, University of Wisconsin.

for introducing flexibility in the now fixed charges for interest can be demonstrated by the Farm Credit Administration the way will be cleared for its still wider use. It is also suggested that the possibilities of a plan of this character be carefully explored by the Farm Credit Administration, as well as by other credit agencies, as a basis for sale of foreclosed properties which are subsequently returned to private ownership.

Development of Tenant-Operation in Place of Owner-Operation of Farm Land: The operation of farm land by the owner was no doubt the ideal of all who favored liberal land policies. European tenant-ridden countries were cited in contrast with America, where every man could sit under his *own* vine and fig tree. It is easy, therefore, to understand the feeling of consternation which prevailed when the census of 1880 revealed that over one-fourth of our farmers were no longer owners but had somehow become tenants in spite of homestead and other liberal land laws. This proportion has increased until 1930, when 42.4 percent of our farmers were reported as renters.

It is not the purpose of this report to discuss all the implications of this changed relation of the operator to the land, but particularly to call attention to the relationship of tenure to the wastage of natural resources. There are many factors which could be mentioned—the question of economic land utilization, community problems, landlord-tenant relationships, and the relation of the whole tenant situation to relief, and other pressing problems.

It was Arthur Young who made the famous statement that an owner's self-interest would prompt him to convert a desert into a garden, but give him a 9 years' lease on a garden and he will reduce it to a desert. While this is an overstatement of the situation, it points out the difference between the attitude of the man who has a direct interest in the land and who expects to hand it to his son unimpaired and perhaps better than he received it, and the man whose only interest is to make as much money as possible, even though he has to exploit the soil. From this standpoint the area of land under tenant operation is really more important than the number of farmers in the tenant class.

The Extent and Character of Tenancy in Different Regions: The amount of farm land under lease in the United States is in excess of 400 million acres (431,587,424 acres in 1930). This represents 43.7 percent of the total acreage in farms. Over half of our farmers (52.8 percent in 1930) operate leased land. Over two-fifths of our farmers (42.4 percent in 1930) lease from others all of the land they operate.

The amount of wastage of natural resources due to tenant farming varies with the type of tenure. Where the interest of the tenant tends to coincide with that of the landowner, and both are interested in conserving soil fertility, control of erosion, and maintaining a woodlot, the land will be conserved with the same faithfulness as on an owner-operated farm. This is usually the case where the tenant is related to the owner and especially where the tenant is an "owner-in-prospect"; i. e., expects to acquire the identical farm which he is renting. The large proportion of our tenants related to their landlords therefore creates a favorable situation. Notwithstanding the fact that about one-seventh of our farm tenants are of the colored race and their landlords almost always are of the white race, about one-fifth of all our tenants lease land from relatives.

At the other extreme are the purely commercial landlord-tenant relationships, especially where cash rent prevails and where the owner is an absentee landlord. Not only does the absentee owner have no interest in the affairs of the community but his self-interest prompts him to oppose all taxes and other charges which benefit the community where his land lies. Having to support institutions in two places, he naturally favors the community where he lives. However, there are many notable exceptions to this generalization.

Land that is not owned by the individual who is resident thereon tends to be viewed solely as a revenue-producing instrument. Such regard as the resident owner may have in his land use for the welfare of his neighbors is not similarly held by the absentee owner. Likewise, his tenant finds the greatest gain in the maximum exploitation of the soil resources during his period of tenure. The absence of the owner frequently means that there is little restraint on this process. Even where the land, rather than being rented, is operated under some form of absentee management, the maintenance of soil resources tends to suffer from the lack of supervision.

Absentee ownership can be gauged in a rough way by the place of residence and the distance the landlord lives from the tenant. A study made in 1920 of the ownership of the rented farms in 194 representative counties revealed the following:

TABLE 22.—*Character of absentee ownership, 194 representative counties, 1920*

Absentee ownership:	*Percent of rented farms*
Owner resident *out* of State (5.3 in 1900)	5. 1
Owner resident *out* of county (21.2 in 1900)	19. 6
Owner *not* resident in county nor adjoining county	7. 5
Owner *not* resident within 3 miles (184 counties)	47. 0
For 31 Northeastern counties	38. 0
For 85 North Central counties	58. 0
For 34 Southeastern counties	30. 0
For 12 South Central counties	36. 0
For 13 West South Central counties	54. 0
For 9 California counties	47. 0

The above figures indicate that up to the present the quantitative position of this type of tenure is not of menacing proportions. Accumulation of large holdings by creditor agencies is the only present indication of any significant increase, but this is merely an involuntary temporary ownership. The distribution of this type of landholding is shown in the following table:

TABLE 23.—*Percentage distribution of land held by corporate and State land agencies, compared with the value of all farm land, by geographic divisions, Jan. 1, 1934*

Division	Land held by corporate and State agencies	Value of all land, 1933
	Percent	*Percent*
New England	0.5	2.6
Middle Atlantic	.8	7.2
East North Central	11.5	19.6
West North Central	55.7	29.5
South Atlantic	9.2	7.9
East South Central	3.8	5.5
West South Central	11.8	11.5
Mountain	3.3	5.4
Pacific	3.4	10.8
Total	100.0	100.0

Mortgaged properties in marginal areas encounter debt distress and succumb to foreclosure much more quickly than in other areas. During the post-war agricultural depression approximately a decade elapsed between the time of most acute distress for the marginal lands in the West and the period of greatest foreclosure in the Corn Belt. For this reason a distribution of lands held by corporate and State lending agencies, as of January 1, 1933, is not reflective of the relative distress of geographic divisions which existed during previous years.

The total value of land held by corporations in 1933 is estimated at $770,000,000 as compared with $511,000,000 in 1932 and $294,000,000 in 1930. The total of these holdings, representing chiefly security that has been taken over for default on indebtedness, amounted to more than 2 percent of the value of all agricultural lands. Approximately one-half of this total lies in the West North Central States with the East North Central, West South Central, and South Atlantic States having about one-third of the total amount.

The great body of these acquired lands represent desirable properties and in due course may be expected to revert to private ownership and operation.

Corporate holdings in the marginal territories are less certain of returning to private ownership soon, inasmuch as much of such land is unprofitable for operation purposes. This land is fit material for consideration for public ownership, for sale with restrictions on use, or for long-term leasing with control of such character as to prevent unwise settlement and use. All temporary ownership, however, is unstable ownership. It means a sale psychology and not a use-and-conservation attitude toward the soil. The sooner this land is restored to stable ownership, the better.

Between the two extremes of "related tenancy" and absentee owners there are many variations. However, the close interest of American farm landlords and tenants in each other's welfare is maintained by the fact that rents are commonly paid in shares and, particularly in livestock production regions, the relationship between the two parties is very close. This relationship is strengthened as the period of renting is lengthened.

Greater Security of Tenure and Maintenance of Fertility: A most needed modification in American practice in the leasing of farms is in respect to the maintenance and improvement of the property. Tenants now but rarely have an adequate incentive to interest themselves in the improvement of the farms they occupy, and owners of farms in leasing them out are not adequately protected against the abuse of their property by their tenants.

The experience of older countries affords ample support for the contention that we should enact and enforce legislation directed at the proper recognition of the right of tenants to make improvements to farms they occupy as these appear to be needed, with the expectation of being able to collect compensation therefor if they are not permitted to remain and use their improvements at a rental not increased by reason of such improvements.

It is believed that a satisfactory solution of the problem of recognizing the right of farm tenants to make improvements with compensation for them if forced to move will go far to solve the problem of instability of tenure among tenant farmers.

Landowners should be informed beforehand of any proposal on the part of their tenants to improve the farms they occupy, with particulars as to cost and with the right to appeal to some proper authority if they deem the proposed improvement to be unreasonably expensive or of unreasonable speculative use should the tenant quit the premises and demand repayment for his outlays. Also, the landowner should have the right to go ahead with the improvements projected at his own expense within some definite period of time and with the right to require such additional rent as will return interest on his investment and amortize its principal before the improvements shall have ceased to have value.

It appears impracticable, because of constitutional limitations, to enact national legislation, making the acceptance of the principle of compensating tenants for improvements mandatory. For the present we must look to the several States for the enactment of such legislation. The National Government may do much to hasten the day when this legislation is passed and becomes effective by cooperating with the several States in arousing public interest in the matter and in conducting the experimentation or research necessary

to establish the factors of depreciation and depletion ordinarily occurring.

Facilitating Land Ownership by Suitable Tenants: Many ways suggest themselves by which the ownership of farms by the operators thereof might be favored. Perhaps the most needed is the generation of a frame of mind that makes for a desire for such owner-operation above all other things. Such a frame of mind cannot be created through legislation, but it can be stimulated and worked for by those in charge of our educational and demonstrational work in agriculture and home economics. Without that frame of mind the passage of measures to make ownership possible can hardly achieve much permanent success.

Most people think of easy credit as the most direct and easy way of stimulating ownership. This method may be effective initially in making it possible for a buyer to acquire a place, but if the special credit terms go with the holding regardless of how it is occupied, there is danger that any subsequent buyer desiring the place for occupancy by himself or as an investment would have to pay a price so much the higher because of the specially favorable interest rates. Other suggestions are presented elsewhere in this report.

Making Available Farm Lands Needed for Future Requirements[6]

Some consideration was given in an earlier section to the question of what lands are available for the additions that must be made to the cultivated land in order to meet future requirements. We may now consider briefly policies that have to do with making such additional areas available.

New cultivable and improved pasture lands needed for future production requirements will ordinarily be made available by means of reclamation, which in its broadest sense includes irrigation, drainage, and the clearing of undesirable brush or stumps. Very frequently drainage is necessary even in irrigation enterprises, and much of the land which remains to be drained must also be cleared.

In the main, irrigation and drainage require collective action, such as by private corporate enterprises, cooperative associations, quasi-public corporations, such as drainage and irrigation districts employing the taxing power or the benefit principle, or by direct Federal or State initiative. Moreover, both involve the use of water and therefore are associated with interests long recognized as strongly imbued with a public interest; and both have a significant relationship to agricultural credit and relief policies of the Federal Government and of the States. It is therefore extremely important that for such enterprises we formulate a well-rounded program of development and control.

Irrigation Policies: Irrigation as here used is merely a means of putting land to work. The paramount use of the national resources is to provide for the needs of human life, and the highest use of these resources is for the greatest good for the greatest number of people.

In the arid part of the United States there is much more land than there is water with which to irrigate the land. It is, therefore, basically sound that the irrigation water supplied should be so guarded as to insure its ultimate use upon the best of the lands which can be economically served by this water. There should be provided for the arid region a well-rounded-out plan of development, and nothing should be permitted to interfere with the ultimate consummation of this plan. No development should be permitted which cannot be fitted into the general plan.

In national land use planning too much importance cannot be given to State, county, and other political subdivision lines. New laws and customs will develop and old ones will be abrogated if Federal participation is to be at all dominant in the development of irrigation projects. Since the less expensive and more easily developed irrigation undertakings have already been largely built, there remain the more expensive and larger projects requiring, in most instances, public funds for their building and more or less associated with the development of power and flood control. These public funds will come quite largely from the Federal Government, but there should be State participation in planning and in developing these larger projects. Where but one State is involved there is required only that State's consent to any agreement, but where two or more States are involved the final decision must rest with the Federal Government if the several States cannot agree, and this should be the basis of Federal participation.

Each project or unit of the project to be undertaken must be measured by its economic feasibility, necessity, or other consideration that might warrant its building, and only in the event that it meets the requirements should it be undertaken. The general policy should be to complete worthy projects already partly constructed and to perfect old developments that may be in difficulty through a deficient water supply or other condition that could be economically corrected. There are many small and seemingly unimportant developments which, though essentially local in significance, in the aggregate are of considerable economic significance. These should be a definite element in the land use plan for the arid portions of the country. For instance, a small area of irrigated land may support a more or less self-contained community or may make available for grazing areas that could not otherwise be adequately utilized.

[6] The following persons have contributed material which has been utilized in the preparation of this section: C. P. Barnes and Francis R. Kenney, Land Policy Section, Agricultural Adjustment Administration; E. W. Lehmann, W. W. McLaughlin, Fred C. Scobey, and J. G. Sutton, Bureau of Agricultural Engineering; and Elwood Mead, Bureau of Reclamation.

The investment of money presupposes a corresponding benefit, direct or indirect. In case of expenditure of Federal funds there should be a national benefit as well as a regional or individual benefit. The individual and the local community should be required to reimburse the Government to the extent of their benefit, and only upon this basis should public funds be authorized for the project. Federal funds should not be allocated for the development of any reclamation undertaking where the use or protection of land for agricultural purposes is involved until the project has first been submitted to the Departments of Agriculture, Interior, and Commerce, or to some Federal coordinating agency (as later suggested) in order that these organizations may pass upon the economic feasibility and/or necessity for the project both regionally and nationally.

There is need for the development of a body of well-defined principles and criteria which can be subjected to thorough scrutiny and criticism by competent authorities and can then serve as a basis whereby the desirability and propriety of given reclamation developments can be judged. Many of the feasibility studies of reclamation projects have been short-sighted and incomplete in that they have not considered adequately the economic consequences of developments in their interregional and, finally, their national relationships. Before any reclamation development or project is authorized involving Federal funds the economic soundness of such project should be studied from the entire regional and national points of view.

More than 30 years have elapsed since the passage of the Federal Reclamation Act. It is highly proper that its purposes and accomplishments be studied in the light of our present and future needs. It was to be a social experiment designed to enable the home seeker of little financial means to realize the fulfillment of his hopes—to offer him what he could not get without Government help.

The placing of settlers on Government projects at a cost much greater than might be found elsewhere is not only indefensible economically but it also fails of social justification.

It is highly important that reclamation policies and national agricultural policies be more closely related. Recently the latter policies have been influenced by the fact that production is excessive in relation to available demand and by the consequent problems of revising sharply the capital structure of American agriculture. The cost of new irrigation enterprises, such as the Federal Government is requested to build from time to time, has reached very high levels.

It is difficult to justify adding to an oversupply of producing area at a cost to the settler, for irrigation alone, of $150 to $250 an acre. The average investment per acre for all irrigation enterprises in the country is less than $40 an acre. The Reconstruction Finance Corporation is engaged in an attempt to salvage over 100 irrigation districts which have found it impossible to meet their obligations, averaging less than $50 an acre. The Reconstruction Finance Corporation has decided these districts are able to pay only $21 an acre and is refinancing on that basis, although it is conceded that adequate study of the capital structure the various projects are capable of supporting has not yet been made. Already 228 of the 363 irrigation districts in the country have made formal application to the Reconstruction Finance Corporation for help.

In fact, it is not necessary to inaugurate new irrigation projects to meet the immediately prospective demand for irrigated farms. There are large areas of irrigable lands lying within the boundaries of existing irrigation enterprises to which the enterprises are not now supplying water.

The cost to the settler will be less if he be located in some existing private enterprise than if he be placed on high-cost new projects to be constructed, and the existing projects also will be helped. In a great many irrigation districts the burden has been too heavy because only a relatively small percentage of irrigable areas have in fact been settled, and the costs could not be spread over sufficient acreage to enable the assessments to be reduced to a reasonable amount.

The table below shows an estimated number of farm units, within existing irrigation enterprises, which are not yet settled. The potentially irrigable areas within existing enterprises which the enterprises are not now capable of supplying with water have been taken as a basis. The acreage available in each State has been divided into the same size farm unit as is most usual in the irrigated districts of the State.

TABLE 24.—*Farm units available or to be available for settlement in existing irrigation enterprises*

State	Size of unit (acres)	Number of units
Oregon	40	8,261
Utah	40	4,986
Washington	40	4,876
Arizona	40	4,117
California	40	3,967
New Mexico	20	2,140
Texas	40	2,008
Wyoming	160	1,027
Idaho	80	999
Nevada	160	580
Colorado	160	554
Louisiana	40	386
Montana	160	334
Nebraska	160	63
South Dakota	160	31
Total		34,329

In addition to the farm units shown in the above table, there are reported to be over 6½ million acres available in existing irrigation enterprises which the enterprises are capable, at this time, of supplying with water, but which are not now being irrigated. These

figures may reflect excessively optimistic estimates of available water and may not take into account sufficiently the suitability of the land and other factors affecting economic feasibility. In general, existing irrigation enterprises should be rehabilitated, financially reorganized, and fully settled in preference to development of other enterprises.

It is true that not all of the unused land within existing enterprises is of desirable quality. However, it is land which was considered irrigable when the project was developed, and lies within the boundaries of an enterprise which has been selected for irrigation ahead of those areas still remaining outside of irrigation enterprises. This fact would furnish some justification for the assumption that these unused areas within enterprises are probably more desirable than most unused areas outside the present enterprises. However, since economic feasibility was given only minor consideration in the selection of many projects and the tendency within an enterprse is to develop the poorer lands last, the desirability of the available land still remaining unirrigated in the present existing enterprises must be carefully determined.

As already indicated, it is entirely possible that certain new low-cost irrigation projects may be found desirable. In the main, these consist of small units where the farmers have lacked capital for construction and have not conceived of the project as large enough for financing under the Federal reclamation program. An extension of the practice of flood irrigation and pasture irrigation, with practically no engineering expense, would be desirable.

Supplemental irrigation in humid or subhumid regions may contribute materially to the productivity of lands devoted to intensive crops. Supplemental irrigation means briefly the supplying of comparatively small quantities of water to overcome a deficiency in soil moisture during short, critical periods of crop development. Where water is readily available at low cost levels in the humid States it can be used to advantage by market gardeners, berry growers, nurserymen, and others. It is anticipated that supplemental irrigation will remain the problem of the individual farmer for many years. Collective action in this direction will not be feasible usually until an irrigation code, based on western experience, is adopted in humid States.

Drainage Policies: Most of the observations relative to irrigation apply to projects for making new lands available through drainage. There is the same need for reconciling reclamation activity with the requirements of national agricultural policy. There has been a similar tendency in many cases to disregard the essential considerations of agricultural and economic feasibility; and to construct projects on the same watershed with little regard to one another and to a unified hydrographic program for the stream or watershed as a whole.

An essential difference is that the Federal Government has not entered the field of drainage with the deliberate purpose of making lands available for agriculture, and on the basis of not charging the landowner interest on construction funds, although its flood protection program has had the incidental effect in some cases of making additional cultivable land available or more serviceable.

While the Nation is now grappling with the problem of agricultural overproduction, the present report indicates that additional arable lands of considerable extent must be made available during the next quarter of a century to meet our probable requirements and replace the poor areas unsuited to continued cultivation. It has previously been noted that a larger part of the required additional area can be obtained at reasonable costs by drainage than by irrigation.

It is recommended that the necessary provision of these new lands not be left to the uncontrolled activity of private, frequently highly speculative, promotion. A logical reclamation policy both for drainage and for irrigation does not necessarily imply Federal responsibility for construction or Federal financing. It should provide, however, for adequate control of newly developed projects in order to insure their consistency with the agricultural policy of the Nation and sound procedure in determining agricultural and economic feasibility. It also should be coordinated with the programs for safeguarding and facilitating land settlement recommended elsewhere in this report.

A logical Federal reclamation policy, both for drainage and for irrigation, should be an essential part of a national land use plan, and should be aimed at a proper coordination with the various major forms of land use. When the need for reclaiming additional lands appears, irrigation projects should compete with possible drainage projects and with other available lands on the basis of economic feasibility, with due regard, of course, for other economic and social considerations, including a unified hydrographic program for a watershed as a whole. As suggested elsewhere in this report, the Nation should make sure that drainage projects are not destroying refuges for wildlife more valuable for that purpose than for farm use when costs of drainage are taken into account.

In the case of some of the larger projects, both for irrigation and for drainage, undertaken with Federal funds, there should be due recognition of the fact that the irrigation or drainage works comprise a bundle of utilities. Such reservoirs frequently assist in the control of floods hundreds of miles downstream, power may often be developed, the water supply of cities augmented, and navigation benefited.

In such projects the costs of reservoirs, dams, canals, levees, and other works should be equitably apportioned

among all those benefited and not placed entirely upon the shoulders of the farmer settler, already overburdened with the task of turning raw desert land or swamps into productive fields.

This policy would recognize and duly provide for proper financial reimbursement by reason of the benefits which accrue to urban areas within and near irrigation projects, not only because of increase in land values, but because of increased business profits to manufacturers, processors, wholesalers, retailers, bankers, and especially in many cases, to railroads and other public utilities. This would greatly lessen local pressure for projects that have no justification except the local desire to enjoy, frequently for only a short period, the benefits derived from the expenditure of Federal funds in the locality.

An immediate problem is that of reorganizing and refinancing large numbers of financially embarrassed irrigation and drainage districts, some of which would not have been economically justified even if they had not been subjected to the severe tests of an unparalleled depression. Partial provision was made for dealing with this problem by an act of Congress authorizing the Reconstruction Finance Corporation to refinance such districts.

In about 1 year the Reconstruction Finance Corporation has refinanced nearly 8 million acres in irrigation and drainage districts. The result will be the elimination of about $100,000,000 from the debt load of the farmer. The bondholder, of course, loses a corresponding amount, or at least officially accepts a loss he had already incurred. This emergency refinancing is of great help to the farmer but fails to strike at the roots of the trouble. Scores, if not hundreds, of existing districts need more than refinancing. They need rehabilitation, elimination of submarginal areas, consolidation of multiple overlapping drainage districts, and reorganization and reallocation of water rights of competing irrigation districts. It is recommended that an adequate land and agricultural program for districts needing that type of reorganization be developed.

Public Policies for Facilitating Land Settlement [7]

We have already noted the necessity for giving direction to private land settlement as a necessary supplement to other phases of the land program already developed. The profound economic changes of the past 5 years, however, have emphasized also the necessity for public policies to facilitate, as well as to direct, settlement, thus supplementing private initiative by public initiative. Various Federal agencies have already embarked on such activities. The Bureau of Reclamation, the Division of Subsistence Homesteads, the Federal Emergency Relief Administration, and the Agricultural Adjustment Administration are all engaged in various land policies that directly or indirectly involve questions of land settlement or resettlement.

Conditions Calling for Public Activity: There are several groups or classes of people both on farms and in other places whose incomes are extremely low, and for whom substantial improvement without relocation appears virtually impossible. This includes families on poor farm land, some of those on better lands whose farms are too small to permit changes in type of economy necessary for control of erosion, certain classes of farm laborers, young men in the country who are unable to acquire farms and who find no opportunities for employment elsewhere, and industrial populations in rural areas which are permanently stranded. The forms which settlement should take will be determined chiefly by the nature and extent of available opportunities for bettering these existing conditions.

Perhaps the group of people most obviously to be considered is composed of those on land too poor to yield a reasonable living under types of organization and methods of farming common to the region. We have already embarked on a policy of facilitating the removal of such families and their reestablishment where conditions will be more favorable to achieving an adequate livelihood. The major regions where these policies should be developed were outlined above.

Another class somewhat related to the one just discussed is that of populations residing in national forest purchase areas or other areas of public ownership where continued residence is incompatible with the primary objectives of public ownership. This problem is most serious in the Southeastern forests where incendiaries are rather numerous. These people are often on poor farm land which is perhaps the chief reason for considering their relocation. Progress is being made with the incendiary problem by educational methods.

In certain areas which are clearly better adapted to agricultural than to other uses there is need of a reorganization involving resettlement of some of the families as a possible solution. There are six types of areas where larger farms are needed to increase unduly low incomes or to make possible methods of soil conservation. Such areas have been described in a preceding section. (See p. 159–161.)

Agricultural laborers are rather generally a low income group with correspondingly poor living conditions. This is particularly true of laborers in sugar beet, truck crop, and fruit-growing areas, who are largely of foreign origin. These people are often migratory, and present serious social problems. Since these industries are now organized on the basis of such a labor supply the problem is particularly difficult of solution.

[7] The following persons have contributed material which has been utilized in the preparation of this section: R. H. Allen, Virgil Gilman, and Erich Kraemer, Land Policy Section, Agricultural Adjustment Administration; David L. Wickens, Division of Agricultural Finance, Bureau of Agricultural Economics.

Another group which should perhaps be given early priority for consideration in any program for settlement is that composed of young men and women in the country. The opportunities for industrial employment formerly open to them have largely been cut off, and at the same time it has become increasingly difficult to find places in agriculture. There is serious danger, lacking employment, of moral stagnation or the development of criminal activities. It has been estimated tha tthere is a natural increase of farm population amounting to about 500,000 per year. This increase must find employment either in industry or inagriculture

In addition to these various problem groups of people in rural areas who require consideration in a land-settlement program, we must also reckon with the industrial and other workers of the cities who tend to seek relief from unemployment by moving to the country, and the proposal of the Federal Emergency Relief Administration to aid in this movement. There are involved the questions of whether or not such a movement should be publicly encouraged, on what scale it should be provided for, and, if it is to be encouraged, whether full-time farms, part-time farms, or some other agricultural pattern should be the objective.

In addition to this urgent unemployment situation of the present, there are long-time developments under way resulting in a shorter working day and working week, seasonal employment, and cyclical unemployment. At the same time, decentralization of certain industries and improvement in means of transport and communication are making it possible for factory and office workers to live in rural areas and have time for some work on small farms or country homes. In this way they may supplement their incomes from wage work and improve their living conditions. There are at present, and are likely to continue to be, many people who will need assistance in securing such farms and homes.

To leave these various groups of people to drift onto land in haphazard fashion will result in the development of new economic and social maladjustments as serious as those which now call for adjustment. In fact, many of the serious maladjustments dealt with in this report are obviously the result of a past laissez faire policy in regard to land settlement. Therefore, a positive public policy with respect to land settlement appears to be a *sine qua non* of an adequate land program.

Past Public Activity in Land Settlement: Throughout the period of westward expansion the public land policy was one of getting the land settled and improved as rapidly as possible. Land was made easily and cheaply available to prospective settlers and the rest was left to private initiative. As already noted, certain features of this policy, as exemplified in the homestead laws, established a size of farm and a type of farming pattern poorly adapted to many areas, particularly in the drier, more inaccessible, or otherwise poorer lands of the semiarid West. Irrigation has also held an important place in this development. Settlement has met with ever-increasing physical resistance, only partly counterbalanced by technical progress and expand-ing markets.

The only public settlement activity of importance, prior to the World War, was that carried on by the Reclamation Service, now the Bureau of Reclamation, on the lands for which irrigation water was beingprovided.

In 1902 the reclamation act culminated a long struggle for Federal participation in irrigation development where private enterprise seemed hesitant.

The settlement phase of the policy was largely the outgrowth of an attempt to preserve the essential features of the homestead acts with respect to residence and agricultural development. Payment was to be made for the public costs incurred. The period of payment was gradually extended from 10 to 40 years with a recent provision for annual payments of 5 percent of the average gross income for the 10 preceding years. No interest was charged on funds advanced for construction. The settlers had to make the needed improvements on their farms. The need for getting the land settled rapidly after water had been made available worked against the exercise of much care in the selection of settlers, and in some projects delays in getting them fully settled increased the burden of carrying charges for those already on the land. Even before the beginning of the serious depression in 1929, many of the settlers had experienced serious difficulties in meeting even the charges that have been expected of them. Serious maladjustments in number, size, and type of farming have developed. Tax delinquency, abandonment, and frequent transfers have been the common experience. Tenancy has increased steadily, and it has become common for owners of farms to live elsewhere. This settlement policy for reclamation projects has resulted in the development of most of the undesirable forms of tenure common to those sections settled under earlier land laws. Many of these difficulties arose out of the necessity of including privately owned lands within the projects and the speculative conditions that arose within the projects.

Just after the close of the World War land settlement was for a time a popular proposal for caring for men returning from military service, particularly those disabled and in need of special aid. The prevailing high food prices further encouraged settlement, and plans were extended to others, military men merely receiving preferential treatment. The Federal Veterans' Bureau sponsored a program of settlement looking to the establishment of colonies, and of the placing of individual veterans on farms in practically every State. While much was done to facilitate settlement, few people were permanently located on farms.

Between 1917 and 1923 thirteen States enacted laws providing for land settlement. The general plan in each case was to purchase, improve, and sell lands for agricultural use, preference being given to men from the military service. The provisions were carried out in only 6 of the 13 States, since in the others action was made dependent upon Federal cooperation in financing.

California launched two group-settlement projects. Washington attempted to settle a selected series of farms scattered about in settled areas. South Dakota made credit freely available for settlement. Arizona placed 40 soldiers on farms prepared for them. Minnesota attempted to settle the best 40-acre tracts still in public ownership. Oregon conducted settlement demonstrations on three farms, each located in an area where guidance for settlers was particularly needed.

These State experiments, except for the demonstration farms in Oregon, were rather uniformly financial failures. This was attributable in no small part to the depression, which came at a very inopportune time. Plans were adjusted to a price situation that was very temporary. These experiences emphasize the importance of keeping settlement activity geared to the need for new farms and making financial arrangements in the light of the price outlook. They likewise indicate the importance of care in the selection of both farm sites and settlers.

Recent Settlement Policies in the United States: It is not surprising that recent public settlement activities are all of Federal origin when we recall the unsatisfactory nature of State experiences in the field. The Bureau of Reclamation has continued to carry on its work. Also, during the past 2 years two new organizations have been created to deal with certain of the problems that have been pointed out and to encourage various kinds of land settlement.

The Division of Subsistence Homesteads was the first of the new agencies in the field. Its establishment was authorized by section 208 of the National Industrial Recovery Act, which provided "for aiding the redistribution of the overbalance of population in industrial centers" by means of "making loans for and otherwise aiding in the purchase of subsistence homesteads." A very broad interpretation has been made of the purposes of this legislation, as is indicated by the following list of major classes of projects undertaken: (1) Workers' garden homesteads near small industrial centers in which small industries are located and where other industries are likely to come; (2) workers' garden homesteads near large industrial centers, usually of heavy industries not likely to decentralize; (3) projects for rehabilitation of "stranded" rural industrial population groups, particularly bituminous coal miners; and (4) projects for reorganization of disorganized rural communities and for elimination of rural slums on lands submarginal for agriculture. With the launching of the rural rehabilitation program of the Federal Emergency Relief Administration and the submarginal land program of this organization in cooperation with the Agricultural Adjustment Administration, projects of the latter class have been relinquished by the Division of Subsistence Homesteads.

The revised program of subsistence homesteads aims primarily at establishing group settlements as demonstrations where industry is the principal source of income but supplemented by agricultural production for family use. Approximately 10,000 families may be provided for by the present fund of $25,000,000. Most of the construction is done for the settlers, and they are expected to repay the costs over a period of years. The maximum amount of local control in planning and constructing projects compatible with the furthering of the major objectives is permitted. It has been found desirable to allocate funds, however, only on the basis of local plans approved by the central organization. The program may be said to be principally in the planning stage. Most of the available funds have been allotted and some construction work has begun, but actual relocation of the people is, for the most part, in the future.

The Federal Emergency Relief Administration has organized a Division of Rural Rehabilitation and Stranded Populations. As the name suggests, the work of this division is concerned at least partially with long-time rather than immediate relief. Its purpose is to aid people who are now on relief in becoming self-supporting. Farm families are to be rehabilitated if possible on farms where they now are, but where this is not feasible relocation is proposed. Likewise, industrial workers more or less permanently unemployed are to be placed on land where they can produce some of their food requirements. These latter two phases involve relocation of people on land. It is now planned to develop a large number of group settlements for stranded industrial workers. In the first instance the families will engage in subsistence agriculture, but it is proposed that steps be taken to develop new industries in these settlement projects which will be the principal source of money income, as well as contribute to the direct supply of community requirements. This phase of the program resembles in many respects the subsistence homesteads program.

Another important aspect of the program is that it is intended to provide for the resettlement of the families who are to be removed from the areas purchased under the so-called "submarginal land policy." While the same procedure will be employed in these cases, it is probable that there may have to be more reliance on

farming and less on industry than in the program for stranded industrial workers, and also that to a greater extent families may be located in already established communities in the vicinity of their present homes rather than concentrated in newly established communities.

This program of settlement is just getting under way; moreover, it is essentially decentralized, being administered by the State emergency relief organizations with a minimum of control from Washington. It is therefore impracticable at this time either to determine the detailed procedures that will be adopted or to measure the success of the program.

Need for Coordinating Federal Land Settlement Programs: It thus appears that we have three Federal agencies engaged in land settlement; the Bureau of Reclamation, the Division of Subsistence Homesteads, and the Division of Rural Rehabilitation and Stranded Populations of the Federal Emergency Relief Administration. Also, we have two major Federal systems for extending credit to home owners—the Farm Credit Administration, and the Home Owners' Loan Corporation—besides a Federal Housing Administration. Naturally, there exists considerable lack of agreement in objectives, considerable duplication of functions, and lack of coordination in settlement activity that results from the administration of these various programs. While this situation may be justified as an emergency development, a unified long-time settlement policy should be developed, and it is more than likely that this cannot be accomplished unless a single Federal agency is made responsible for the function of facilitating the establishment of farms and homes in rural areas. The financing of settlers may perhaps be handled best by a specialized credit agency insofar as it falls within the scope of its activities.

Scope and Objectives of Land Settlement Policy: While it is perhaps not within the scope of a land report to recommend the adoption of a program for the revival of industrial activity, it seems equally inappropriate to assume that such a program will not be carried out and that the unemployed must be absorbed in agriculture, a procedure involving hardships for the people concerned as well as a serious menace to established agriculture already economically unbalanced. Therefore it is recommended that no substantial movement of unemployed people from urban areas into commercial agriculture be publicly encouraged. It is imperative that the problem of industrial employment be solved in other ways than by trying to make farmers of the urban unemployed. In fact, to the extent that it is not solved, there will remain an acute problem of providing for the large and increasing surplus of farm population which should normally find employment outside of agriculture. This implies that we should alleviate the major volume of unemployment by temporary relief measures, including make-work programs, while taking proper steps to restore industry to normal functioning.

There are certain of the unemployed, however, who, because of old age and the changing demands of industry, will not be taken back into their old occupations even with substantial industrial revival. Some of these people might well be aided in securing rural homes and land for the production of a part of their own subsistence.

The integration of agricultural and industrial employment by the establishment of homes for industrial workers where they may produce part of their living from the land while obtaining a money income from other occupations should become a permanent national policy. While theoretically it may appear to accentuate agricultural competition through reducing the proportion of the population who provide a market for commercial agricultural products, the effect is much less than if the same families should engage in commercial agriculture. The development of part-time farming in an integrated agricultural-industrial economy will mean that a smaller proportion of the supply of certain farm products will come from highly commercialized farms. There will result a greater degree of self-sufficiency for both the families and the communities concerned, to the extent that production is for home or local consumption. This is a natural tendency resulting from the development of good roads, motor transport, rural electrification, such decentralization of industry as has occurred, a shorter working day, and seasonal employment. Even without a public policy this type of economy is likely to develop much further, but it is highly desirable that public aid and direction be given its development in order that it may follow the lines most socially desirable and that some of the abuses that would otherwise emerge may be avoided. Rural, as well as urban, workers may be accommodated in such a pattern.

With the development of public interest in promoting a closer integration of agricultural and industrial employment, requisite national policy needs to be broadly conceived. In addition to the establishment of new communities in which industries are to be induced to locate and suburban programs of settlement in the neighborhood of existing industrial centers, a broad national program would include: (1) Encouraging location of industries under proper conditions in rural areas now seriously deficient in sources of income; (2) reconstruction of existing rural industrial communities that under laissez faire policies took the form of wretched houses huddled around a mine or a factory with insufficient land for food production; (3) planning

for the integration of agricultural and industrial employment in the case of relocating industries; (4) locating industries on the periphery of large cities in relation to rapid transit facilities to the countryside as a definite objective in city and regional planning; and (5) developing the public land program with the definite aim of integrating employment on public lands with employment in agriculture.

At the present time our knowledge does not admit of being able to determine positively the probable success in inducing industries to locate in agricultural areas or new land-settlement enterprises. As long as industrial stagnation prevails it is obvious that industries find it difficult to incur the additional capital charges necessary to reestablish themselves, that business is likely to be hesitant to develop new industrial enterprises, and that the development of such new enterprises may tend to aggravate the problems of competing businesses elsewhere. Furthermore, the relocation of existing plants may have the effect of leaving behind stranded industrial populations in the former locations. In view of these uncertainties and considerations it would seem to be the part of wisdom to proceed slowly in the establishment of agricultural settlements planned in the hope of obtaining most of the money income from the establishment of industries within the settlement area. If a large number of such agricultural settlements should be established, and it should be found difficult to accomplish the industrial side of the program, the effect would be to create a new set of stranded populations living in agricultural units too small for commercial farming and lacking other forms of supplemental income. At most, it would seem wise to begin with a small number of experimental settlements until it can be determined by actual experience whether supplemental industrial employment can be made available to the settlers.

As for the more definitely agricultural areas, it should be a major objective of settlement policy to facilitate necessary readjustments in those areas, such as alleviation of conditions in excessively poor farming areas requiring removal of some or all of the population and the removal of excess population where necessary to permit the adoption of modes of farming suited to soil conservation. It should also be a major objective to provide homes and employment opportunities for those families in rural areas who cannot be absorbed in nonagricultural employment. Insofar as possible this should take the form of establishing homes where supplementary sources of income can be made available. However, unless we find a way to provide nonagricultural employment for the great bulk of the surplus farm population, it will be necessary to provide homes on the land in an attempt to obtain the major part of the livelihood from farming. In such an eventuality, a considerable amount of economic self-sufficiency for communities as well as for farms might develop, with both the community and the farmer buying fewer and fewer goods.

The success of a settlement program for agriculture will depend upon the ability to locate better alternatives for the families under consideration. As a broad generalization, it may be said that there are no extensive unsettled areas suitable for full-time commercial farming under prospective conditions of the next few years. There are some available irrigated lands and drained lands where fuller occupancy has been restrained by overcapitalization. There are also many holdings scattered throughout better farming areas which, because of type of ownership, are not operated as completely or as intensively as they might well be, either through lack of capital, or other limitations. There are undoubtedly some unduly large commercial farms which could be subdivided into a larger number of family farms. Subdivision of existing family farms, however, should proceed with caution, for the safe presumption is, until otherwise demonstrated, that a smaller size might prove uneconomical. As shown earlier in this report, there are large areas of potential agricultural land not yet settled, but it is by no means clear that under present price levels, or even at the prices prevailing before 1929, such land can repay the cost of making it ready for farming and yield a decent livelihood.

State and Federal Relationship in Land Settlement Policy: State and Federal collaboration in the development of land settlement policy is important. Since the rather disastrous State experiences following the World War Federal agencies have stood alone in this field. Insofar as possible the actual development of settlement projects should be decentralized, and local and State collaboration enlisted. It is probable that local corporations should bear a considerable responsibility for the expenditure of funds in acquiring and improving land, constructing buildings, and in selection of settlers. Furthermore, the sense of responsibility would be emphasized if local contribution of part of the funds were required. Federal guidance, however, is necessary in the interests of an integrated plan for land use. The fact that the States where adjustments involving land settlement are most needed are least able to provide financial aid makes it necessary that a large proportion of requisite funds come from Federal sources. Occasionally interstate aspects of settlement further necessitate Federal action.

Settlement Procedure: In deciding upon procedure in land settlement, past experience, both domestic and foreign, should be used to the fullest extent. Details, however, must be worked out locally, and experimental departures from past experience should be frequent.

This emphasizes the importance of competence on the part of settlement agencies. The size and type of farms desirable will necessarily vary greatly according to the locality and to the characteristics of the prospective settlers. No single system of farming can fit all areas. However, all new patterns of farming designed to accommodate settlers should provide opportunity for settlers' families to grow part of their own food and also to expand their enjoyment of rural community living. A fundamental requirement is opportunity for either the production of a substantial volume of agricultural products to be sold or for part-time employment in other occupations. This opportunity may be for a member of the family, not necessarily for the operator of the farm or the head of the household.

If the farms are of such a type as to cause any significant increase in, or redistribution of commercial agricultural production, their establishment should be coordinated with the broad plans for national agricultural readjustment.

In this country the policy of freely disposing of public lands to those wishing to settle upon and cultivate them has been rather unsuccessful in establishing permanent operator-ownership of farm land. In a settlement program it is desirable to establish a form of tenure that will encourage stability of occupancy, the proper maintenance and development of the property, and discouragement of speculation and absentee ownership. There are many arguments for the policy of retention of ownership by the public settlement agencies and leasing the land to settlers with suitable guaranties for security of tenure and compensation for unexhausted improvements, as discussed in a preceding section of this report. On the other hand, the traditional emphasis on land ownership in America is an important psychological element not to be ignored. It seems wise to employ an elastic policy and to employ the form of tenure that best fits the individual case. For instance, where a group of small holdings or part-time farms is essentially dependent on a single industry for employment, tenancy under suitable conditions may be a wiser policy than ownership, so that the family may be free to seek other employment if for any reason it loses the opportunity for regular employment. There are also many families who do not have the habits of industry and thrift or the managerial competence that would justify allowing them to assume a large indebtedness in order to purchase a home. On the other hand, where the proper qualities exist, and particularly where the individual has reasonable asset status and strong interest in ownership, he should be allowed to incur the necessary obligations. Payments for farms, however, should not be permitted to cut into the funds needed for operation or improvements or for the living of the family. In sections of high land values this may make land ownership impracticable.

In the past, many difficulties have arisen in settlement projects from certain farms getting into incompetent hands and being sold and resold, as well as being put to uses incompatible with the settlement policy. To avoid this difficulty, as well as to protect the settler from investing in an enterprise which he is not qualified to carry on, a trial period before entering upon a purchase contract may be employed to advantage. The settler might take over the farm on a rental basis for a period of 4 or 5 years with the assurance that if he managed it satisfactorily he would have an option to purchase at the end of that time, and that in any case he would receive compensation for any permanent improvements he had made. In order to prevent speculative acquisition or the passing of the property into incompetent hands it may be desirable to provide for recapture by the settlement agency on payment of assessed value.

An important question is how far public settlement agencies should go in improving and equipping the farm for the settler. This must, of course, vary with local conditions and more particularly with the financial status of the settler. In this country in the past the tendency has been to err on the side of doing more than the settler could pay for, doing certain things not adapted to his particular needs, or providing improvements which he could more economically make with spare-time labor. In general the settler should be left to do the maximum amount of which he is capable, but he should not be forced to apply his labor inefficiently for lack of capital. His holding should also be in condition to contribute materially to his livelihood from the start. This is especially important when a heavy credit obligation must be incurred.

Credit Facilities: The Farm Credit Administration has accomplished a great deal recently in making agricultural credit more generally available at low interest rates. Borrowing privileges have been extended to part-time farmers. Perhaps the chief obstacle remaining is that farmers borrowing to buy land can obtain not more than 50 percent of the appraised value on first-mortgage loans, and cannot get loans from the Farm Credit Administration on second mortgages. The settlement agency, therefore, may frequently find it necessary to finance the settler to the point where he is eligible for a loan through the Farm Credit Administration. It is recommended that the so-called commissioner's loans, now restricted by law to refunding operations, be authorized for employment in facilitating the purchase of small agricultural holdings when these constitute an essential part of a

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Federal or State small-holdings program. In the case of rural homes or part-time farms where there is insufficient agricultural value to make possible a loan by the Farm Credit Administration, the Federal Home Loan Banks are in a position to furnish credit. This type of credit should be recognized as a part of their responsibility. It is especially important in all types of settlement to arrange contracts with settlers according to their probable ability to make payments. It is no kindness to sell a man a home on a "shoe string" and put a millstone of credit about his neck if his prospects of repayment are hazardous.

Training and Guidance: Comparatively little attention has been given in this country to the training of prospective settlers or to their subsequent guidance. It has been assumed that if men could only be helped to acquire farms the rest could well be left to their individual initiative. The subsequent experiences of settlers do not support this assumption.

Organized courses of instruction arranged at the agricultural colleges could be of much help in giving prospective settlers a better orientation. Such courses might be required of inexperienced farmers and be made optional with others. In addition to this the Extension Service, with its present tendency toward greater participation in public programs of regulation and control, might well engage actively in advising and guiding new settlers.

SECTION III
II. THE PROBLEMS OF RANGE LAND[1]

Ineffective and Wasteful Use of the Range and Conditions Responsible

Approximately 46 percent of the area of the United States—884 million acres—is range land, most of which is in the arid and semiarid regions west of the one hundredth meridian. Of this range land, about one-third is owned by the State and National Governments and two-thirds by individuals, railroads, and land and cattle companies. Most of the remaining public domain, and substantial portions of the Indian reservations, national forests, and national parks may be classified as range lands. Eleven of the principal range States own over 43 million acres, most of which are used for grazing.

The effective use of a type of lands which comprises such a large proportion of the Great West naturally is of vital importance to the future growth and progress of much of that area, and indirectly, of considerable importance to the entire Nation.

The public domain early came to be considered a great grazing commons on which no control or regulation existed, and the cheap, abundant forage available thereon permitted the rapid development of a prosperous western livestock industy. Stockmen, under the spur of financial necessity, have practiced overgrazing on their own lands. The unreserved public domain, some 168 million acres of range land in the West, has lost from 40 to 50 percent of its productivity. (For the extent of depletion, see the accompanying map, fig. 52.) Inefficient livestock production, increased starvation losses, higher supplemental feeding, and other production costs, and sacrifice sales have undermined the financial stability of the range livestock industry. Wide-spread bank failures, closed rural schools, and embarrassed county governments have resulted in range areas.

In many parts of the range territory range deterioration has exposed the soil to abnormal erosion. In such areas local floods have increased in number and destructiveness, range productivity has been reduced as much as from 40 to 90 percent, irrigation reservoirs and other works have rapidly silted up, thus increasing costs and threatening the permanency of irrigation farming. Erosion in one State may cause loss and expense in another. Restoration of cover is needed to check erosion and otherwise improve watershed values.

Sustained-yield management, which safeguards all resources of range land—forage, watershed, etc.—would assure most beneficial use both to communities, and to the public generally. This applies equally to private and public range lands.

To the overexpansion of the livestock industry, the disastrous wars between sheep and cattle men, overgrazing, erosion, and gradual reduction in the carrying capacity of the range, was added one last great blow at the cattle and sheep industry, the coming of the homesteader and the resulting break-up of much of the range land.

Under the assumption that the process of carving out farms could continue successfully in the semiarid regions if the 160-acre free homestead were increased, the Enlarged Homestead Act of 1911 and the Stock-

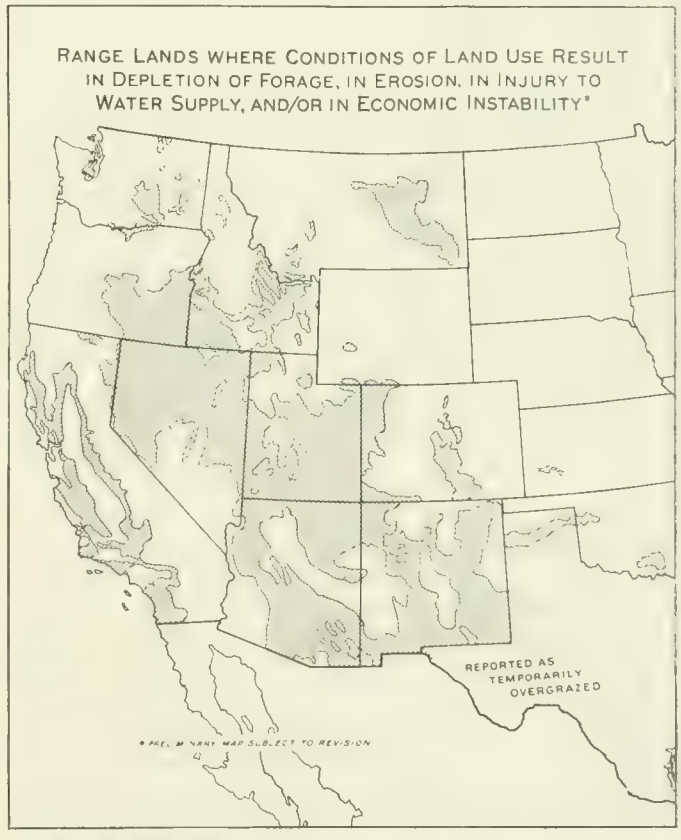
RANGE LANDS WHERE CONDITIONS OF LAND USE RESULT IN DEPLETION OF FORAGE, IN EROSION, IN INJURY TO WATER SUPPLY, AND/OR IN ECONOMIC INSTABILITY*
REPORTED AS TEMPORARILY OVERGRAZED
* PRELIMINARY MAP SUBJECT TO REVISION

FIGURE 52.—Overgrazing or other injudicious use of range, particularly on the public domain, has resulted in depletion of forage, in soil erosion, or in disturbing irrigation water supplies. The Taylor Grazing Control Act will, when its provisions are carried out, effect controlled grazing on part of the public domain, but measures of adjustment will be needed on private and on Indian lands.

[1] The following persons have contributed material which has been utilized in the preparation of this chapter: L. F. Deeds and Depue Falck, Geological Survey; H. W. McFarran, General Land Office; W. R. Chapline, Forest Service; Paul W. Gates, Land Policy Section, Agricultural Adjustment Administration; and E. O. Wooton, Bureau of Agricultural Economics.

Raising Homestead Act of 1916 were passed, thus permitting the entry of 320- and 640-acre homesteads, respectively. The result was a flood of new settlers who occupied the range, completely destroying the winter range in places and thus upsetting the previous interdependence of mountain summer range and the winter range of lower altitudes. It mattered not that a high percentage of failures shortly appeared among these new homesteaders and that the abandoned entries—some 15 million acres—were frequently ruined for grazing purposes; the laws remained on the statute books and the disastrous homesteading continued.

The stockmen's only defense against the homesteader was to buy him off or frighten him away from the community. Both expedients were resorted to without complete success and frequently the remedy only aggravated the stockman's situation. Wars were costly, and to buy out the homesteader required much capital which only the larger cattle men possessed. Even they frequently were ruined by the heavy expenditures necessary to acquire the intruding homesteader's land. To protect himself, the stockman has been forced to acquire land from the Government, often illegally, in order to insure sufficient forage and water for his stock.

As a result of the cutting up of the ranges and the decline of their carrying capacity the stockmen have slowly come to the realization that only withdrawal of the lands from entry and the establishment of some sort of control over them will save the livestock industry. Withdrawal of the lands from entry or repeal of the entry laws will not end the overgrazing, and control of the range is therefore necessary. Private control has not worked, State control is relatively untried, but Federal control within the national forests has been successful, even according to the exacting standards of the stockmen, and therefore the conclusion is inevitable that control must be established by the Federal Government.

The Taylor Act

The demand for a change in our land policy that will put an end to improvident homesteading and establish adequate control of the public range led to the passage on June 28, 1934 (48 Stat. 1269), of the Taylor Grazing Act. This act authorizes the withdrawal from entry of 80 million acres of vacant, unreserved, unappropriated public domain and its organization into grazing districts to be administered by the Department of the Interior. It also authorizes administration of grazing on land included in withdrawals amounting to about 30 million acres insofar as grazing is consistent with the purposes of the withdrawal. Furthermore, where the public domain occurs in isolated, disconnected tracts, the land is made subject to grazing leases under such conditions as may be deemed necessary or appropriate by the Secretary of the Interior. The Secretary is also authorized to make exchanges, accept grants of private lands, and sell isolated tracts which can best be administered by private ownership. Broad powers are conferred on the Secretary to do any and all things necessary to accomplish the purposes of the law, namely, to regulate occupancy and use of grazing land; to preserve the land and its resources from destruction or unnecessary injury; to provide for the orderly use, improvement, and development of the range; and to continue the study of erosion and flood control and to perform such work as may be necessary amply to protect and rehabilitate the range lands.

The first step of the Department after passage of the act was to hold meetings in various parts of the public-land States where stockmen and others interested were invited to present their views. Opinions obtained at these meetings are of value in formulating plans for administration that will best serve the combined, private, State, and Federal interests involved. A Division of Grazing has been created in the Department, a Director of Grazing Control appointed, and an administrative organization is being established.

Lack of regulation in the past, the evils of which have been accentuated by the drought, has created a very serious situation for the livestock industry. The demand for range feed is far in excess of the supply, and there is urgent need to bring the land under control in order that the available resources may be utilized in an orderly manner. The Department is therefore proceeding rapidly in organizing the grazing districts. All public land in Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, and Wyoming has been withdrawn from entry for classification and in aid of administration of the Taylor Act. Surveys are being made for water development, and various other investigations are under way for the improvement and best use of the range.

The following table shows the total public domain area exclusive of national forests, national parks, and Indian reservations:

Status of the public domain on July 1, 1934

	Acres
Unreserved and unappropriated lands	165, 695, 479
Withdrawals	30, 442, 832
Unperfected entries, much of which will revert to public domain	24, 080, 779
Total which is or may become subject to entry	220, 219, 090

The 80-million-acre limitation in the Taylor Act leaves an undetermined acreage of unreserved land subject to administration under other provisions of the law or to a continuance of the indiscriminate and unwise homesteading which has caused so much social and economic distress in recent years. The continued overgrazing and destruction of the range on

such acreage also may occur. For these reasons the limitation is deemed unwise.

National Policies Relative To Grazing on the Public Domain

A thorough-going change of land policy has been initiated by the withdrawal of the principal public domain regions in aid of administration of the Taylor Act and pending classification to determine what lands are suitable for agriculture, grazing, forestry, reclamation, or other uses, and when so classified these areas can be assigned to the land administering bureau under which they would naturally fall.

Full use will be made of the exchange provision of the Taylor Act which authorizes the exchange of public domain land for privately owned land within the grazing districts provided for in the act. The 80 million-acre maximum limitation upon the amount of land which may be placed in grazing districts does not limit the amount of privately owned land within the districts which may be thus exchanged for isolated or scattered public-domain land elsewhere. It is therefore possible, if the exchange clause is liberally used, to block up most of the public lands within these districts.

The policy for the remaining public lands established by the Taylor Act contemplates land planning on a State-wide scale. It authorizes the creation of economic units under which public range resources will be utilized to permit proper use of small ranch set-ups that are the foundation of the present civilization in the West. These ranches will be classified to determine their dependence upon public grazing privileges and the amount of such privilege required to round out each unit. This program will be made coordinate with and supplemental to the submarginal land purchase program. It will recognize that there is no justification for the continuation of a land system which permits homesteading upon land which can only bring calamity and ruin to the homesteader and destruction to the natural resources of the Nation. Vigorous cancelation of improper entries will be a logical part of such a program.

State and county range lands that require establishment of sustained-yield management, including lease and inspection provisions to assure reasonable compliance, can be made a part of the program provided cooperative agreements can be negotiated. Consolidation of isolated holdings through exchange will be possible to facilitate administration.

Tax reversions, homestead relinquishments, and purchases will undoubtedly increase public holdings of range lands. Purchases will be required chiefly to withdraw submarginal dry farms from production, to round out public administrative units, and possibly to relieve overburdened owners of low-value range lands.

The necessity of many western livestock owners using different range areas for winter, spring-fall, and summer grazing, the need for safeguarding the interests of the established settler and owner, and for sustained-yield management of the whole, require thoughtful integration of the use and management of lands in the several ownerships. The success with which the Forest Service has stabilized use on areas of intermingled ownership within the national forests and coordinated such use with community development for public welfare is an example of the cooperative administration that is specially provided for in the Taylor Act.

Range land values will be rated upon productive possibilities, which will require adjustments in tax assessments, etc. If tax assessment is required, State grants-in-aid or other assistance will have to be provided.

SECTION III
III. FOREST LAND PROBLEMS AND POLICIES[1]

Areas That Should be Devoted to Forests as a Primary Use and Recommended Intensities of Management

All land capable of growing forests and for which no higher social or economic use or need exists or can be foreseen should be maintained in or restored to forest cover for the twofold purpose of conserving its soils and of deriving from it products or services of social and economic importance most readily obtainable through the agency of trees.

The selection of different degrees of intensity of management for various areas should be determined in accordance with the following general considerations:

Intensive management should be adopted for those lands for which timber production and related uses appear to be the highest economic and social service, and upon which highly developed wood-using industries and/or communities are, or soon will be, vitally dependent for economic existence and progress. The adoption of intensive management in any area, however, should be made with due reference to the relation of prospective timber production to increased costs of management as compared with extensive management or mere protection, for a number of the important social values derived from a forest cover are not necessarily dependent on intensive methods of silviculture.

Extensive management should be employed for those lands for which timber production and related uses apparently will be the highest ultimate economic and social service; but where the present or immediately prospective value of timber products and the associated social values, when duly considered in relation to costs of management, do not justify other than extensive types of forest management, which will conserve and gradually improve the forest cover without an immediate and complete realization of the optimum growing power of the soil.

Merely protective measures should be adopted for lands upon which the maintenance of a forest cover is essential for the adequate protection of the soil or to provide wildlife with its necessary environment, or to stabilize stream flow or to conserve scenic beauty, but not as a primary source of timber supply; in view of which the only requirements of management are protection against fire, insects, or tree diseases, provision for recreational and other uses, and the establishment and maintenance of such physical improvements as may be essential to those ends.

Of 615 million acres now in forest, as noted above, 509 million acres are physically capable of use for commercial timber production, although this does not mean that on all of it timber production would be commercially economic without consideration of the various social values involved. The Forest Service, on the basis of a series of local surveys, recommends intensive management on 295 million acres, extensive management on 150 million acres, and merely protective management on 64 million acres. It does not follow, however, merely because the interests of particular localities would be advanced in the immediate or remote future by intensive forest management, that either private timber owners or the Federal or State Governments would be justified in incurring the necessary costs throughout the aggregate estimated area. A policy of management for each area designated would necessitate more careful consideration of all the factors involved than was possible in this survey. Of the remaining 106 million acres in forest, 45 million acres should probably be in specialized recreational use, 5 million devoted to miscellaneous special uses, and the remainder, much of which is chaparral, pinon, juniper, and other species of desert woodland, should be managed for watershed protection, wildlife production, recreation, and grazing. The Forest Service estimates that 3 million acres on the Great Plains should be devoted to forest shelter belts, and an undetermined acreage on submarginal farms or farms or fields rapidly deteriorating from erosion should be planted to trees as the most suitable form of protection. This will consist of extremely steep slopes or soils too poor for economical employment in pasture.

Figure 53 is a map showing the areas recommended by the Forest Service for the three intensities of management.

Progress in Forestry and Major Problems

A review of progress made in placing forest lands under organized fire protection indicates that from 1891 to 1930 the area not under organized protection dropped from 530 million acres to 190 million. Of the

[1] The following persons have contributed material which has been used in the preparation of this chapter: L. F. Kneipp, C. E. Behre, E. A. Foster, B. F. Heintzleman, R. F. Hemmingway, F. A. Ineson, G. H. Lautz, Helen B. Smith, W. N. Sparhawk, and J. M. Witherow, Forest Service. The field organization of the Forest Service and State forestry and conservation departments, planning boards, experiment stations, land planning consultants, and other organizations and individuals aided in the field survey of present and recommend forest ownership and intensity of management.

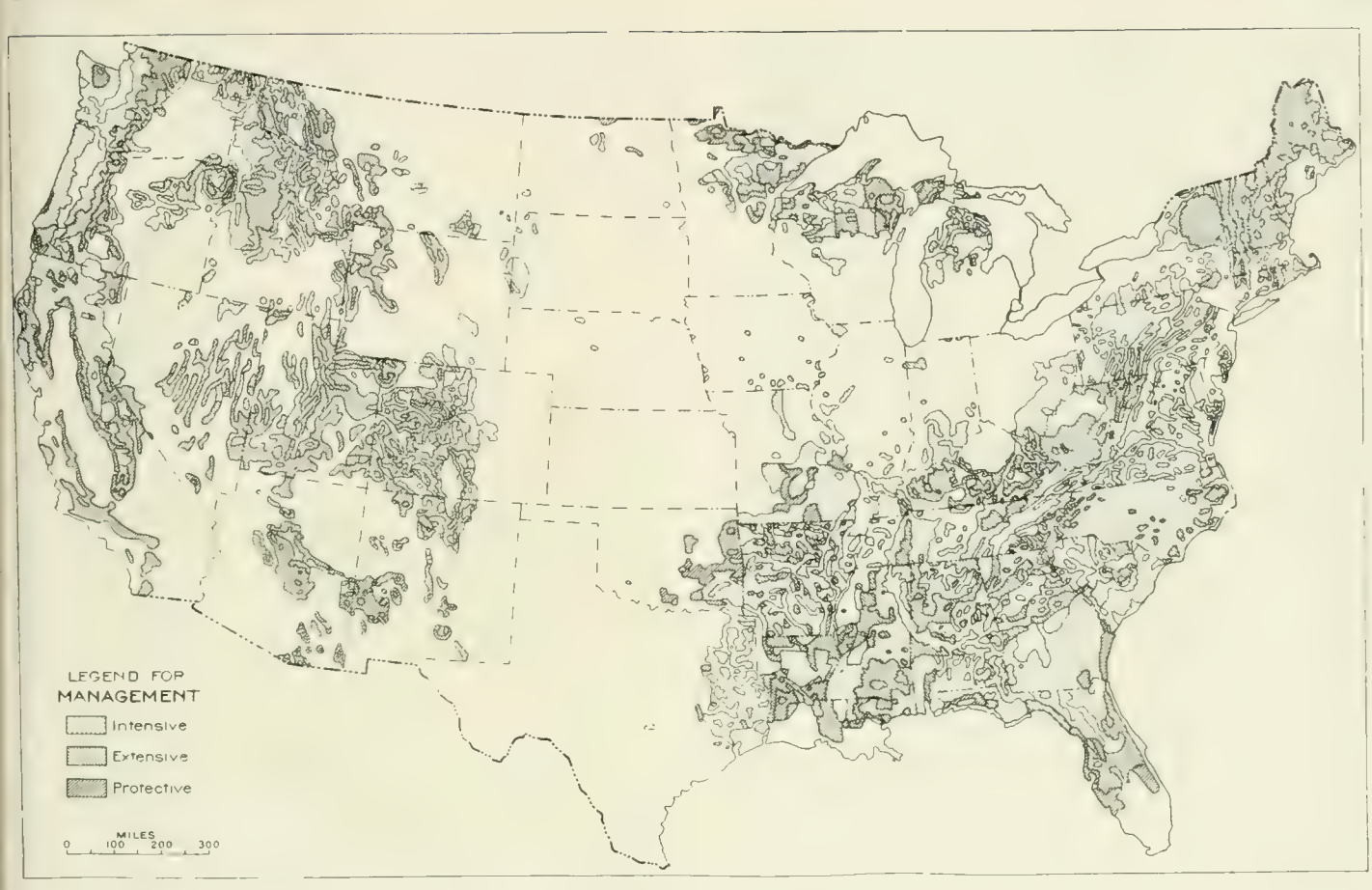

FIGURE 53.—Recommended dominant intensity of management of forest land.

FIGURE 54.—Present dominant intensity of forest management.

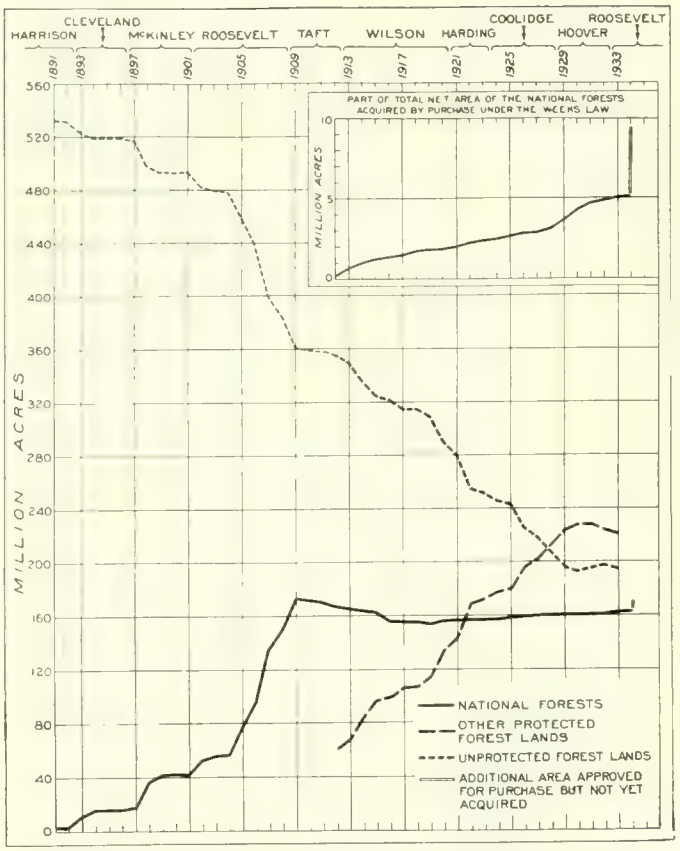

FIGURE 55.—Progress by placing forest lands under organized fire protection, 1891 to 1933.

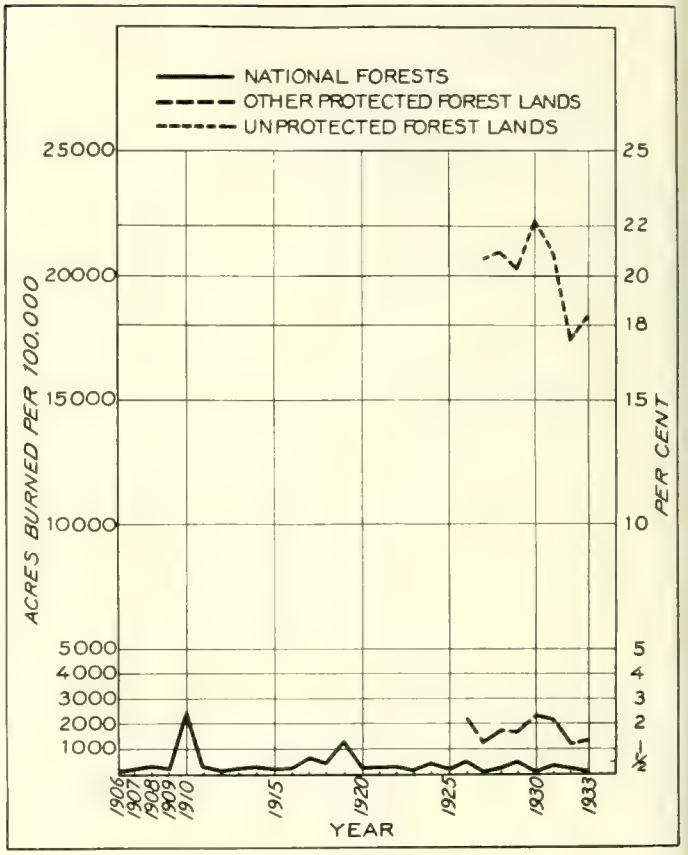

FIGURE 56.—Area burned annually by forest fires, 1906 to 1933.

protected lands, 161 million acres were in national forests in 1931, 230 million were in organized State protection districts partially financed by Federal aid under the Clarke-McNary and Weeks laws. From 1930 to 1933 there was a decrease of 7 million acres in protected lands, and a corresponding increase in the unprotected land. This was due to straightened financial circumstances which forced certain States to reduce their fire-protection expenditures. Statistics for 1934, when available, will show an appreciable recovery from these set-backs, partially through the impetus given to the State forest organizations under the emergency program and partially through the creation of 31 new national forest-purchase units and extensive additions to old ones, and a greatly expanded forest-acquisition program as a result of allotments of $20,000,000 under the Emergency Conservation Act. Out of this fund 4,892,874 acres have been approved for purchase at an average rate of $2.26 per acre.

Figure 55 shows graphically the expansion of the national forests, the increase in the acreage of other protected lands and the corresponding decrease in unprotected acreage, and the decrease in protected area from 1931 to 1933.

Figures 56 and 57 show the fire losses on the three classes of forest, the national forests having an average loss of 0.224 percent in acreage burned for the period 1927–33, the other protected lands 1.88 percent, and the unprotected lands 20.75 percent.

Because a large part of the protected lands receive no organized management, figure 55 is misleading in that it gives the impression of conditions better than actually exist. Figure 54 is a map showing the present intensity of forest management, indicating the lack of intensive management or even of any management at all over large areas. It also shows the areas not under organized protection. Since the creation of the national forests, there has been little progress in placing forest lands under organized management. Most of the lands that have been placed under such management are publicly owned forests. Privately owned timber lands continue to be destructively exploited, and local forest bankruptcy, stalking upon the heels of "boom" conditions created by rapid liquidation of forest capital, has been and continues to be a drastic reality for hundreds of communities in the forest regions. Not only is timber unduly sacrificed under such exploitation, but recreational, wildlife, and watershed values are destroyed or seriously impaired. The aftermath is millions of acres on which growing stocks are so depleted that public acquisition and management offer the only means of restoring the forest to a productive condition. Nor is sound forestry practice being generally applied voluntarily to extensive stands of volunteer second growth as they reach maturity. (See fig. 58.)

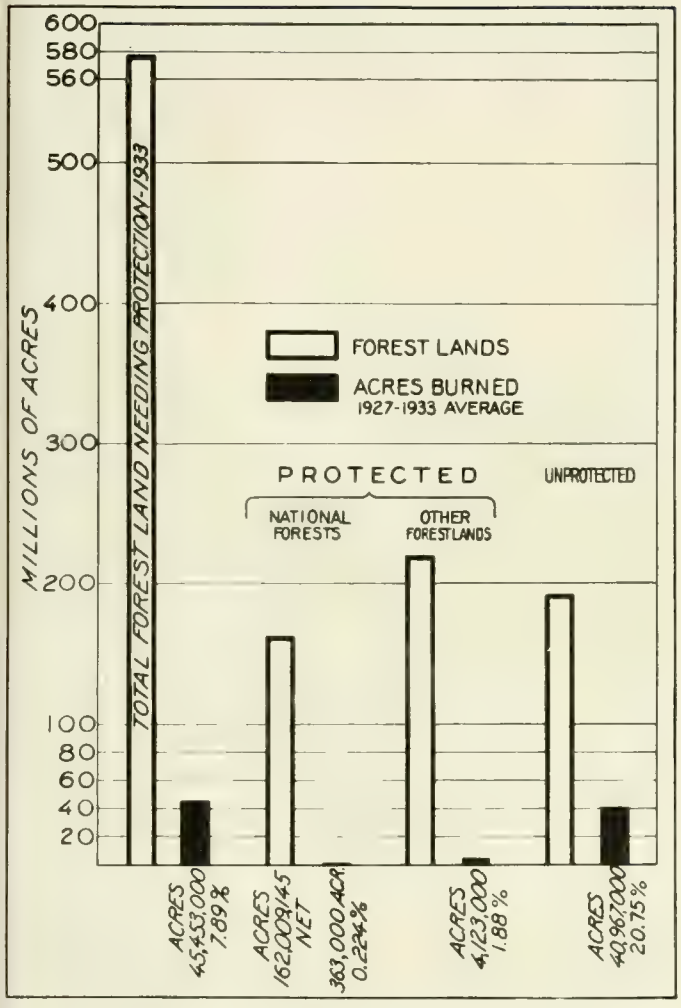

FIGURE 57—Relation of area burned to forest area, 1927–1933 average.

The argument that was used 30 years ago, that forestry knowledge was not sufficiently advanced to undertake the application of silvicultural measures and regulation for sustained yield, is invalid today.

Although much yet remains to be learned before the methods best adapted to each local condition are determined, applicable principles and methods are available for all major forest types. Lack of forest knowledge can no longer be cited as an alibi for failure to stop the destructive exploitation of forests.

FIGURE 58.—Submarginal (undersized) logs cut from unmanaged second-growth forest. Planless exploitation is extending to stands of volunteer second growth throughout the country, and in some respects is even more wasteful and uneconomic than the planless exploitation of virgin forests.

Two courses of action are open: (1) Public acquisition and management of forest lands, and (2) industrial self-regulation or, insofar as this proves ineffective, through public regulation of the activities of private forest owners.

Public ownership is recommended for forests badly depleted by mismanagement or otherwise not amenable to profitable operation in private ownership, and for forests in which the public has a special interest for recreation, watershed protection, or the stabilization of local economic conditions. Private ownership might be relied on to realize the economic and social values inherent in stands of mature and second-growth timber favorably located in relation to markets, soil, and other factors, and not overburdened with taxes and interest payments on borrowed capital, providing adequate measures are taken to safeguard the public interest either through industrial self-regulation or through public regulation.

Present and Recommended Ownership of Forest Lands

Accompanying is a table showing present ownership and ownership of land as recommended by the United States Forest Service:

TABLE 25.—*Present ownership and ownership of forest land recommended by the Forest Service*

[Millions of acres]

Ownership classification	Area in 1930 [1]	Area in 1934 [2]	Increase or decrease since 1930	Recommended by 1960 [3]	Recommended increase or decrease
Private:					
Farm woodland	150	150	.....	124	−26
Industrial	294	285	−9	133	−152
Total private	444	435	−9	257	−178
County and municipal	[4] 2	5	+3	5	.....
State	16	17	+1	77	+60
Federal:					
National forests	108	113	+5	243	+130
Public domain	24	24	.....	10	−14
Other	21	21	.....	23	+2
Total Federal	153	158	+5	276	+118
Total public	171	180	+9	358	+178
Grand total	615	615	..	615	..

[1] According to the estimates of Dr. O. E. Baker and table I, p. 1243, A National Plan for American Forestry, 1933.

[2] According to estimates covering 1,755 counties or appreciable portions of counties embracing 510 million acres of forest land and adjusted for the balance.

[3] From recommendations of forestry field agencies and cooperators for area of statistical inquiry and adjusted for the balance.

[4] Increased from 1.5 to 2 million acres to eliminate use of fractions.

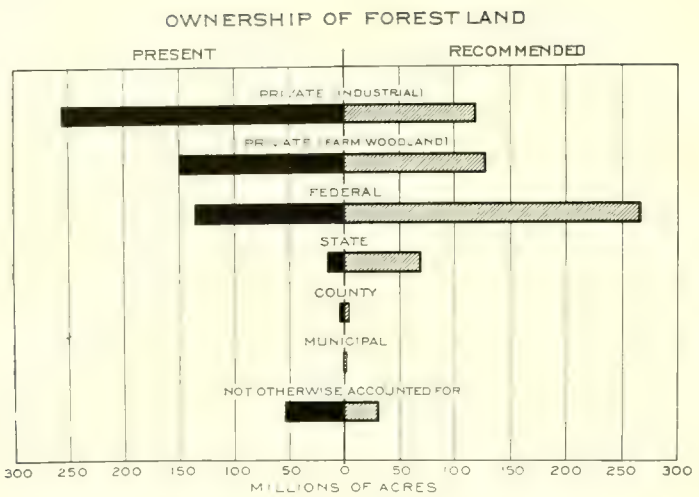

FIGURE 59.—Present ownership and ownership of forest land recommended by the U. S. Forest Service (total area accounted for, 614.6 million acres)

Figure 59 is a bar chart showing the same information in graphic form, exclusive of forest land in Indian reservations and national parks. Figures 60 and 61 are maps showing the location of the same lands.

The following is a table showing the acreage recommended for each intensity of management under each class of owner:

TABLE 26.—*Acreage recommended by the Forest Service for various kinds of management, by type of proposed ownership*

Owner	Total	Intensive	Extensive	Protective
Private	257.0	114.0	87.0	56.0
Federal	257.0	129.0	48.0	80.0
State	77.0	49.0	14.0	14.0
County and municipal	5.0	3.0	1.5	.5
Sub-total	596.0	295.0	150.5	150.5
Specialized areas	19.0	....	....	....
Grand total	615.0	....	....	....

These recommendations, which will be discussed in the following pages, are a summation of the recommendations of local land-planning, forestry, and conservation agencies. In most instances they represent the joint opinion of the State forestry agencies and the regional foresters of the United States Forest Service. In numerous instances the State and regional land-planning consultants of the National Resources Board, the State planning boards, and regional directors of the Land Policy Section of the Agricultural Adjustment Administration have collaborated in working out or have reviewed the recommendations. Other agencies, such as State universities and experiment stations, have also collaborated. These recommendations call

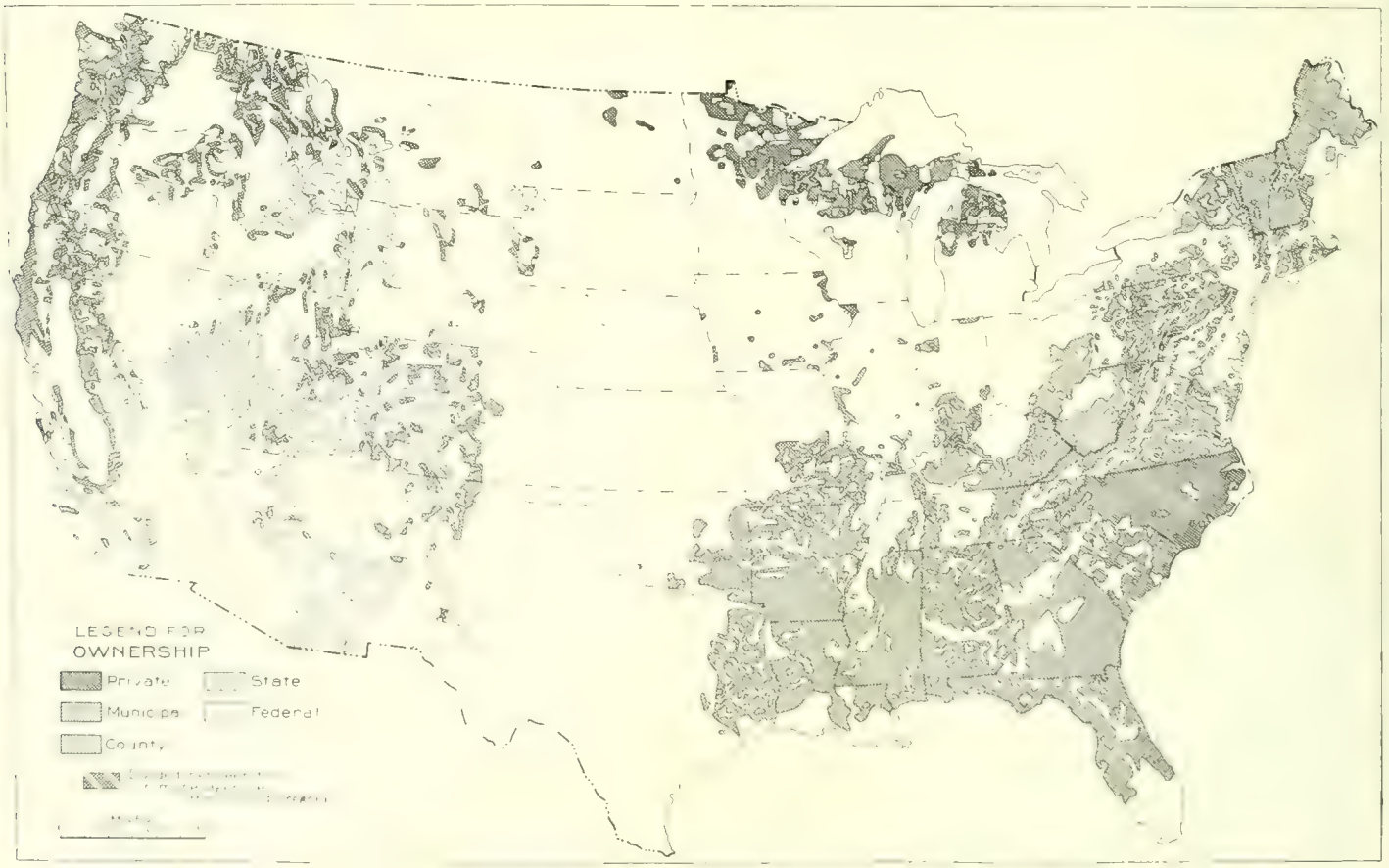

FIGURE 60.—Present dominant ownership of forest lands.

for larger acreages to be placed under intensive management and in Federal ownership than were proposed in the Copeland report. Various reservations and qualifications with reference to these proposals were given earlier in this section.

Areas that Should Continue in Private Ownership

As suggested above, forests favorably located in relation to markets, having good growing conditions, and with growing stocks that have not been seriously depleted by fire, overcutting, and lack of proper silvicultural treatment, and not overburdened with taxes and interest payments on borrowed capital which cannot be readily liquidated, have a possibility of being so managed under private ownership as to realize their economic and social potentialities, provided either that adequate industrial self-regulation or sufficient public control is exercised to insure good silvicultural practice and sustained-yield management.

The forests recommended for private ownership are the areas on which private enterprise appears to have the best chance to make a profit out of forestry. The experience of a few companies, combined with the results of economic studies, indicates that under favorable conditions it is fully as possible to make reasonable profits from the businesslike management of forest lands as from other forms of productive wealth.

In addition to commercial forest lands in large holdings, farm woodlots are for the most part recommended for continuance in private ownership. (Fig. 32, p. 141, is a dot map showing distribution of farm woodlots.) Detailed studies of local conditions, however, will indicate instances where the public interest will be served by placing groups of farm woodlots under public ownership for two major purposes: (1) Use for public recreation, wildlife, watershed protection, and erosion control; and (2) demonstrations of organized management of scattered holdings of timber in highly developed agricultural sections where premium prices on timber make possible very intensive forms of silviculture.

Location, Area, and Present Use of Forest Land Recommended to Continue in Private Ownership: The commercial forest land (productive forest land other than farm woodlots) recommended for continuance in private ownership is located largely east of the Great Plains except for a considerable acreage in the Pacific Northwest.

The present use of the forest lands recommended for continued private ownership, with a few notable exceptions, is characterized by lack of organized management, planning, silvicultural measures, and provision for sustained productivity. But in general these lands are areas which have suffered less under planless exploitation or have shown greater recuperative powers than

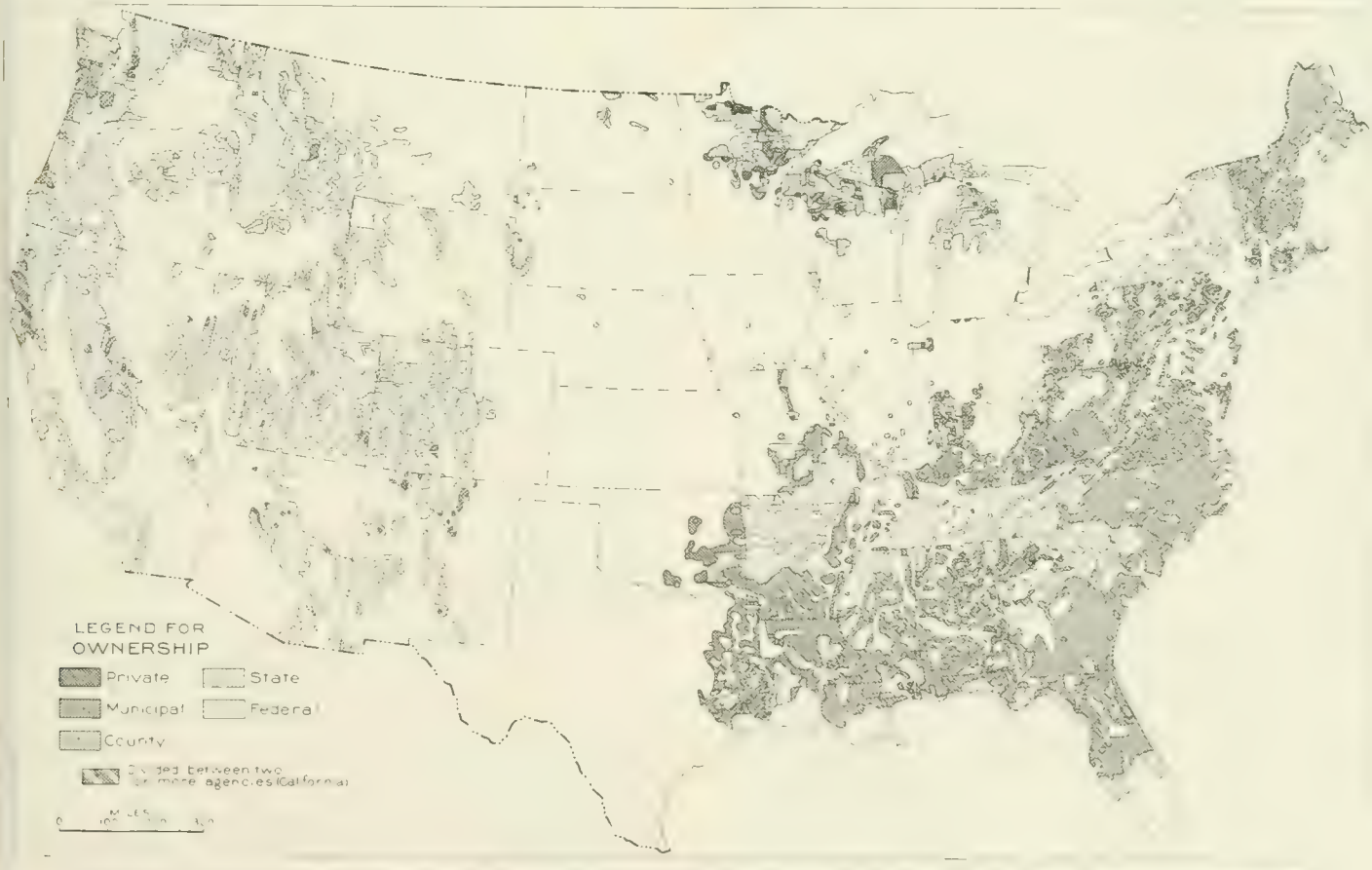

FIGURE 61.—Dominant ownership of forest lands as recommended by the U. S. Forest Service, on the basis of the survey of local reconnaissance surveys.

the areas recommended for public ownership. They include large areas of volunteer second growth as well as stands of original timber in which cutting has not yet taken place.

The present system of exploitation of these forests pays low wages to workers, offers little assurance of permanent employment, and destroys values upon which continued production and continued employment depend. Either industrial self regulation with more or less public collaboration, or outright public regulation appears necessary in order to secure general application of sound forestry principles to the management of the greater part of the privately owned lands.

In general, social values are likely to be more or less disregarded on privately owned areas. The recreational use of areas recommended for continued private ownership is generally less than on the areas recommended for public ownership, recreational use being one of the criteria employed in deciding whether a given area should be in public or private ownership. On most privately owned forests little attention is devoted to wildlife management, and there are likely to be restrictions that severely limit the wide-spread public enjoyment of wildlife resources.

Farm woodlots are subject to variable treatment. In many of them heavy grazing is gradually destroying their value as forests. In some sections periodic burning does extensive damage. Even in the woodlots protected from fire and grazing poor silvicultural treatment and overcutting reduce the productivity to a very appreciable degree. Wildlife values are usually not given adequate considerations. Vigorous educational programs should be directed toward the improvement of farm woodlot management.

Measures Needed to Provide Conditions More Favorable to Private Forestry: Measures directed at the provision of more favorable conditions for the private management of forest properties can be divided into two classes: (1) financial aid, (2) indirect aid through research and dissemination of information.

The various types of measures recommended for financial aid may be summarized as follows:

1. Taxation: Local tax burdens should be adjusted to rest more evenly on all forms of productive wealth and relieve forest lands from bearing more than their proportionate share. More economical and efficient local government in forest districts is needed to reduce the total burden in such districts, while better administration of the property tax, together with a proper adjustment for deferment of income, would bring about a better distribution of the burden.

2. Public loans to private forest industries at low interest rates, provided operations are adjusted to sustained-yield management and a reasonable provision is made for safeguarding other social interests in the forests.

3. Government aid in the construction of forest road systems for fire protection and for public travel, and to facilitate motorized logging.

4. Public aid in fire protection and the control of insect and disease outbreaks. (See below, p. 215.)

5. In general, public regulation requiring compliance with certain minimum silvicultural standards and sustained-yield management, provided that industrial self-government proves unavailing in realizing these objectives.

6. Public acquisition (or exchange) of forest land and timber to aid owners who can benefit by liquidating part of their holdings and blocking up the remainder through exchange.

7. Reduction of the excessive volume of timber going to market, in order to relieve the pressure to liquidate which now jeopardizes most of the remaining stands. This would make it easier for private owners to manage their remaining timber for sustained yield. It would benefit the public through reserving additional high quality stumpage for future use when more urgently needed than now. The situation is most serious on the Pacific coast. In part, the industry itself is responsible through the speculative acquisition of excessive stumpage at an earlier period. Material readjustments in indebtedness incurred and in tax burden would be necessary, and collaboration of timber owners would be required for the solution of the problem by the industry itself. Failing such a solution, the Federal Government may be forced to acquire these excess holdings, but this should be done only with due allowance for the remote period at which this timber can enter consumption and the carrying charges that must be incurred in the meantime.

8. The logical place for restriction is upon the volume of timber cut in the forest, through placing timber management on a sustained-yield basis. Need exists, however, for the reduction of excess mill capacity and the concentration of the allowable cut in efficient mills where maximum economy of operation results in reduced costs, thus making possible good wages to labor and low prices to consumers.

9. Federal aid has been provided for a number of years to assist States in the distribution of forest planting stock to farmers and to provide advisory service for the management of farm woodlands. Provision should be made for expanding these services and extending them to all classes of owners, and also for extending the provision for advisory service. The expense should be shared equally by the Federal Government and the States.

A public program of aid in forest research and extension, including forest-products research, can benefit private forest operators in several ways:

1. Investigation and dissemination of information on logging methods better adapted to sustained-yield

management and to desirable types of silvicultural treatment.

2. Investigation of silvicultural methods and systems of management.

3. Forest products research to develop more efficient and better methods of utilizing forest products.

Measures Needed to Safeguard Public Interests in Privately Owned Forest Lands

Dispassionate analysis of the past and present status and condition of the privately owned forest lands in the United States has demonstrated that with relatively few exceptions their management has been and continues to be a process of destructive exploitation, not only of the virgin forest but of extensive stands of volunteer second growth approaching economic maturity. The net consequences are waste and impairment of a great natural resource, transient and economically insecure employment, decadence, fiscal disorganization, and dissolution of dependent communities. The American people must decide whether they will follow the old course or adopt the twin policies of (1) industrial self-regulation and public regulation of forests adapted to private management, and (2) public ownership of the other forest areas. Even industrial self-regulation will require public collaboration, for otherwise those private owners who sincerely desire their forest lands to be managed constructively will be almost hopelessly handicapped by the competition of forest owners who exploit their properties without limitation.

Economic factors fix certain limits of forest productivity and value below which private initiative cannot realize adequate returns from properties managed with full regard to the public interest. Where that condition prevails, public ownership is dictated. Above that limit, private management deserves all encouragement. If with such encouragement, however, private management fails to redeem the obligations of its ownership, there should be no hesitancy in bringing such lands under public control, and if that proves ineffective, then in bringing them under public ownership.

Among the lines of action variously suggested for safeguarding the public interest and insuring the fuller realization of economic and social values inherent in the forests and forest lands recommended to continue in private ownership, the following merit serious consideration:

1. Coordinated provisions by Federal and State agencies to maintain permanently adequate forces of technicians to review management plans developed by forest owners, particularly the smaller owners, to inspect woods operations and production records, and investigate and advise operators as to the best forest practices. The aim should be to aid private owners to conform to certain minimum standards of silvicultural treatment, including limiting the annual or periodic harvest of timber to not more than the estimated sustained yield for the areas.[2]

2. Ample penalties for violations, enforceable under the police powers of the States or by a combination of State and Federal action.

3. Forest operators or owners unwilling to comply with silvicultural requirements and sustained-yield restrictions to be given the option of selling their forest land and timber to Federal or State Governments or exchanging their land for Government timber.

4. Management of small holdings, farm woodlots, etc., to be integrated with a general program of planned land use through such public provisions as are recommended in this report for conservation of soil or farm lands.

Areas That Should Ultimately Be in Public Ownership

It is believed that public acquisition offers the only sound and workable solution of the forest problem in areas where growing stocks have been heavily or wholly depleted by destructive logging, fires, and other causes; areas where profitable operation for timber production may be impossible for private enterprise but where the public interest in watershed, wildlife, and recreational values can be served only by organized management; areas which might be operated profitably by private owners, but on which the public need for recreation and related uses makes public ownership highly desirable; privately owned forest lands interspersed with existing public forests and purchase units; lands submarginal for agriculture for which the highest use is forestry and related uses, and which could not be profitably converted to forestry under private ownership; and stands of timber otherwise destined to destructive exploitation in private ownership because of excessive capital costs or for other reasons, but only as a last resort and subject to the provisions mentioned above. (The Forest Service recommends that the public acquisition program include 90 billion feet of standing timber in the Northwest.)

Location, Area, and Present Use of Areas Recommended for Public Ownership: The Copeland Report (p. 1283) estimated that 257 million acres should be in public ownership for timber production. The current study based upon more intimate analysis of local conditions recommends that 244 million acres be placed in public ownership for timber production, and an additional acreage of 114 million of noncommercial for protection, recreation, wildlife, etc. (See above, p. 210.) Figures 60 and 61, showing present and recommended dominant ownership of forest lands, give the location of areas in each class of ownership.

[2] Exceptions should be allowed in some measure in the case of virgin stands of timber or temporarily during periods of national emergency.

The present use of the private lands recommended for public ownership is largely destructive and uneconomic. Timber values are planlessly exploited without consideration to silvicultural requirements or sustained productivity. As already noted, destructive and uneconomic exploitation of merchantable stumpage is not confined to the remaining stands of old growth timber but finds a new field of activity in extensive stands of second growth as they approach merchantable size. The greatest economic loss in the exploitation of these stands arises from harvesting them before they have reached sufficient size to furnish logs or bolts which can be exploited profitably. (See fig. 58.) The result is a poverty-stricken industry operating spasmodically and forcing operator after operator into loss of invested capital or bankruptcy. Recreational values suffer from abuse and neglect, and wildlife resources from mismanagement and the destruction of natural habitats.

Probable Distribution of Ownership—Federal, State, or Local Government: Because of the interstate character of the dependency upon forest resources and other benefits deriving from forest lands, a large part of the acreage recommended for public ownership is recommended by the Forest Service for public ownership by the Federal Government. This recommendation is also partly due to the fact that many of the States most important as to source of timber supply for neighboring States are unable to finance the entire or major portion of the forestry program within their boundaries. The recommendations of the Copeland Report (134 million acres additional for Federal ownership, 89 million for State) are believed by the Forest Service to have been liberal in their estimate of the ability of the States to finance forest programs.

In the present study, based on a more detailed survey, the Forest Service proposes that 118 million additional acres be placed in public ownership for Federal, and 60 million for State ownership.

Present Program of Acquisition and Suggestions for its Extension

The Weeks and Clarke-McNary laws authorizing the purchase of forest lands have no geographic limitations, but to date have been used only in the eastern United States. The exchange program is based upon 56 separate acts of Congress, the most important being the acts of March 20, 1922, and of March 3, 1925, which provide for the exchange of timber on national forest lands for land located within the national forests and best suited to forest use. To date approximately 1 million acres have been added to the national forests through exchange and 10 million acres either acquired or approved for purchase within national forests or purchase units. The purchase program was given great impetus in 1933 by the allotment of $20,000,000 from the Emergency Conservation Fund for the purchase of forest land under the above-named acts. Figure 55 shows, among other things, the growth of the national forests through purchase. (The ultimate distribution of public ownership as recommended by the Forest Service is shown above.)

A program of acquisition to accomplish these increases could be financed by bond issues paying low rates of interest, and the entire program consummated in 10 to 20 years. A large part of the acreage is already tax delinquent and a revision of State laws to perfect tax titles would make possible the acquisition of tax-reverted lands by the State or county at little or no cash outlay. When so acquired they could be exchanged to other agencies where necessary to consolidate holdings. Provision for exchange should be part of the acquisition program. (See general discussion of public acquisition policies and tax delinquency, below.)

Measures for the Administration and Development of Publicly Owned Forests

The management of public forests should provide for simultaneous development and use of all the resources and services of the property in proportion to their relative importance.

Timber use should be planned to stabilize dependent communities, and to provide for local as well as national future requirements. The national forest system of controlled use of forage under permit favoring small local ranch owners and involving planned construction of range improvements has proved highly successful. Restriction of other uses wherever watershed values are paramount is a sound principle, but exclusion of other uses is seldom necessary. Recreational use may be dominant in densely populated sections, but generally requires only a small percentage of the total area for intensive or exclusive development. Preservation of wildlife involves protection and control both of the wildlife stock and of the environment.

The first responsibility of forest administration is protection from fire and other enemies. The second is to direct the use of the forest resources according to a plan that will insure continuous yields and maximum social and economic benefits. The third is to build up and improve the resources of the forest, insofar as results justify the necessary cost, so that these resources may yield greater social and economic benefits. Part of the expenditures for this work must be considered as the price of past mismanagement. They can be likened very aptly to payments made for the purpose of balancing an overdrawn bank account.

It calls for intensive silviculture in some areas, tree planting, stream improvement, game management, and provision of additional recreational facilities. For the relief of unemployment a forest-work program has advantages over many other forms of public works, because it can be made at least partially self-liquidating

in commercial terms and partially also in terms of social and indirect economic benefits.

A fourth responsibility is to integrate the forest land program with other major land uses, especially agriculture, to render maximum social and economic service. This responsibility has only recently been recognized in its larger implications. To redeem it, requires a program of resettlement of populations now located on submarginal farms, the more complete integration of forest employment with part-time farming, the stabilization of communities through providing regular employment, the conversion of submarginal farms to forestry or other uses, and the reorganization of local government and fiscal arrangements in forested areas.

Cost of Acquisition and Maintenance, and Extent to Which National Forests May Be Self-Supporting

For the 10-year period 1921–30 receipts from the national forests amounted to $53,623,374. Administration and protection costs were $74,818,314. Capital investments of $48,447,866 account for the balance of the total of $123,266,180 expended on the national forests during the period. These investments were in the form of improvements, largely transportation and communication systems. Under policies more concerned with profitable exploitation than with broad social and economic values and the building up of resources, greater returns could have been realized. But such a full commercialization would have served the general good less well than a policy which sells the rancher and farmer stumpage at cost for farm use, which reduces grazing fees in times of economic stress, which preserves timber because of its æsthetic value, which maintains extensive recreational facilities for the free use of the public, and builds up game, fish, and other resources in addition to the commercially exploitable ones, such as timber.

The Forest Service estimates that to meet desirable public objectives in protection and administration of the national forests would require annual expenditures averaging 12.2 cents per acre (of which 6.8 cents would be for protection), as compared with the average of 8.1 cents per acre (5.7 cents of which was for protection) provided in the past. Of this, 4.6 cents would be for current administration and 7.6 cents for capital investments, including forest highways. As improvement programs were completed, investment expenditures would be reduced accordingly. The Forest Service estimates that a program to build up and improve the resources of the existing forests and give employment would require an average annual expenditure of 48 cents per acre for 5 years and 30 cents per acre thereafter. Acquisition costs of the program of public forests recommended by the Forest Service, judging by experience under the Weeks and Clarke-McNary Acts, would average $4 per acre acquired, and commercial stumpage $12 per thousand. Investments to furnish needed facilities for administration and protection and perform the most urgently needed planting and silvicultural work in land to be acquired will average $2 per acre in the East and $1 per acre in the West.[3]

The Forest Service estimates that the initial cost plus the cost of development, protection, maintenance, and administration will be largely liquidated by receipts after the growing stocks have been built back to normal. But because the most productive forest land is recommended to remain in private ownership and because it will take from 20 to 60 years or more to build up depleted growing stocks on a large part of the lands recommended for public ownership, it will be a considerable time before receipts would approximate expenditures. Other sources of revenue, such as rentals on special use sites, grazing fees, etc., will more than pay administration and other costs directly chargeable to those activities. A system of publicly owned cabins to be rented to recreationists is a further means of making recreational use pay its own way, and should be given favorable consideration.

Nonincome producing values, such as watershed protection, wildlife, social values, etc., are difficult to measure in commercial terms. Nevertheless, they have large importance.

Measures for the Protection of Public and Private Forests

Protection of forest resources is a primary consideration, yet 190 million acres of forest land in 1933 still lacked any form of fire protection. Present fire protection is far from satisfactory, except on the national forests (see fig. 56), and even there increased effort is required on critical areas totaling over 30 million acres. The annual costs of fire control are estimated to average 5.8 cents per acre on the national forests and 4.8 cents per acre elsewhere. Total expenditures for adequate fire protection would have to be materially increased.

Federal aid in forestry activities, in which Federal cash contributions are matched by equal or larger expenditures by the States, has been developed as the most practical way to exert an immediate and wide influence for progress in forest conservation. Federal aid for fire protection is made contigent upon the existence of State organizations meeting definite standards. Results thus far justify the recommendation that Federal aid go forward up to 25 percent of the estimated needs for adequate fire protection in each State as fast as the States provide their required quota. The primary need in protection against insects is for an

[3] In the East, estimates for protection costs should apply to double the area acquired during the period of accumulation of ownership in new units.

organized system to detect outbreaks in their early stages. Effective quarantine measures must be taken by public agencies to afford protection against tree diseases. A trained service force to assist owners and to apply disease-control measures is recommended. More adequate provision is needed to check the white-pine blister rust in the West. Federal activities in study and control of forest insects and disease constitute an important form of indirect aid to the States and private owners. In addition, direct financial aid for the detection of insect outbreaks is recommended, provided an adequate share of the expense is contributed by State and local agencies.

Forest Research and Extension

The management and utilization of either public or private forests cannot be placed on a high level of effectiveness without comprehensive and sustained research. Research is needed in a number of major fields. Research in forest management and forest range management should be gradually extended to areas and forest types not yet covered. In forest economics there is urgent need for accurate information regarding the economic factors affecting forest management, forest and wood-using industries, the need for forests and forest products, and public policies with respect to forestry. Forest-products research is necessary to bring about the most effective use of wood and other forest products. Research in forest entomology and forest pathology is important in order to develop methods of preventing or minimizing the heavy losses caused by insects and diseases. Research is needed also as a basis for the control and management of the wildlife population of the forests. Research in forest influence has clearly established that forest cover affects stream flow and local climate and retards erosion, but has not yet accurately measured the effect of various vegetative and site conditions.

Forest research has been and will continue to be very largely a public function. National leadership is essential, but research by State and other public and quasi-public agencies and by forest industries should be greatly expanded. The results of forest research should be made available to forest owners and users through an adequate system of forest extension and demonstration work.

SECTION III

IV. THE DEVELOPMENT OF THE NATION'S RECREATIONAL RESOURCES[1]

Government activities in the development of recreation resources can provide but a small part of the needed opportunities for and types of recreation which healthy and abundant living requires. As pointed out in the previous section of this report, recreation assumes a multitude of different forms, and a great majority of recreational uses of land are outside the field of public action.

Private recreational activity needs governmental support and some types of recreation have been recognized as a particular responsibility of government. First of all, protection is needed against abuses—prevention of pollution of streams, control over billboards and similar interferences with enjoyment of sport and scenery; second, there is need to prevent exclusive use of great resources in which the public as a whole has an interest; third, there are large groups of people who have neither the means nor leisure to get out of our great industrial centers and who must be provided with open spaces and recreational facilities at minimum cost; and, finally, there are areas and monuments which only the Government can protect and preserve for continued enjoyment by succeeding generations.

Park Requirements of Municipalities

The primary foundation of a national recreation plan is within the municipalities and their immediate environs. The essential problem is to provide places for rest and active recreation for the inhabitants of these municipalities within such easy reach that they may be used very frequently. Essential recreational requirements of any municipality include adequate and properly distributed play areas for children and adults, "in-town" small landscape parks, and a few parks of the types generally referred to as large parks. For municipalities of 8,000 inhabitants or over, as already noted, the provision of 1 acre of recreation area to each 100 persons appears to be a desirable minimum, of which 30 to 50 percent would be comprised of play areas of various types.

In cities where the minimum requirement is 1 acre to every 100 persons, the total recreational area might be divided approximately as follows: Children's playgrounds, 12 percent, composed of units from 3 to 8 acres in extent; neighborhood play-fields, from 15 to 18 percent, depending on the kinds of recreation to be provided, the two types totaling 30 to 50 percent of the whole. The balance would be composed of equitably distributed neighborhood or "in-town" parks and large areas characterized by landscaping or natural features, in acquisition of which it is desirable when possible to exceed the standard minimum acreage by a comfortable margin.

Park and Playground Requirements of Metropolitan Regions

Provision of park and playgrounds for the populations of metropolitan regions comes next in importance in the national recreational scheme. Here planning involves provision of recreation service for the inhabitants of the principal cities of a kind which cannot effectively be supplied within those cities; and, in addition, recreation service for residents of smaller "satellite" cities and of immediately tributary rural farm and rural nonfarm areas.

Determination of responsibility for provision of lands required for recreation within metropolitan regions is a complex matter. A number of cities have gone well beyond their borders in acquiring parks. Counties, special metropolitan park districts, and States may all serve as agencies for provision of metropolitan parks. A very large number of States have shown themselves disposed to accept a liberal share of responsibility for provision of the large outlying areas characterized by better than average natural scenery or by high active-recreation value. They continue to play an important part in the metropolitan park field.

The Federal Government, without reference to any well-developed plan, has established recreational areas of various types within metropolitan regions. Through its emergency program of submarginal land acquisition, it is acquiring lands intended to meet the recreational needs of industrial populations in metropolitan areas.

There is as yet no definite policy concerning division of responsibility between the several agencies involved, nor any definite standards relative to amount of area or

[1] The following persons contributed material which was used in the preparation of this chapter: Harlean James, American Civic Association; Niel M. Judd, National Museum; A. B. Cammerer, H.C. Bumpus, A. E. Demaray, H. A. Tolson, H. C. Bryant, G. A. Moskey, T. C. Vint, C. M. Finnan, Isabelle F. Story, W. A. Blossom, John D. Coffman, and Conrad L. Wirth, National Park Service; George M. Wright, John Nolen, Jr., Herbert Evison, B. H. Thompson, R. W. Toll, L. H. Weir, G. A. Hospidor, R. E. Phillips, R. W. Pierson, J. J. Hengstler, Donald McLaughlin, and R. H. Walton, of the Recreation Section, National Resources Board.

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administrative method. However, the State may well accept a considerable measure of responsibility for the large, outer-zone parks. The metropolitan park board or the county, depending on the individual situation, may function satisfactorily for the inner, more heavily populated zone. Regardless of the agency or agencies involved, however, planning for recreation should be on a unified basis for the entire metropolitan region, usually extending for some 40 to 60 miles from the heart of the central city.

State Systems

The responsibility of the State appears to be to acquire, develop, and maintain such areas as will meet with reasonable adequacy the needs of its own people for inspiration, nature education, and active recreation, and such as are not the responsibility either of the political subdivisions of the State or of the Federal Government. Among the types of open space which now form parts of State park systems are:

1. State Parks: Areas which are high in scenic value and offer fair opportunity for recreation, or which are of distinctly scenic character and exceptional active recreation value. Preservation of native fauna and flora is essential to the character of any State park.

2. State Beaches: Special attention to the reservation of beaches for the enjoyment of the people in the more densely occupied areas along the Atlantic, Pacific, and Gulf coasts and the Great Lakes is especially needed.

3. State Monument: An area which is dominantly of historic, prehistoric, or scientific value.

4. State Wayside: A rest and picnic place adjacent to a highway.

5. State Parkway: An elongated park traversed throughout its length by a highway.

With reference to the selection and administration of State recreational areas, the following considerations have been suggested:

1. That State recreation systems be based upon comprehensive surveys by qualified persons.

2. That factors to be considered in selection of areas include the following: Unusual or unique natural features; scenic quality, by comparison with that of other areas in the State; probable adequacy of lands obtainable for expected kind and quantity of recreation; variety and quantity of active recreation yield; probable ability to produce legitimate income; location with respect to using population and to competitive areas; relative significance of historic, prehistoric, or scientific values.

3. That delimitation of boundaries be based upon the following: Inclusion complete of any outstanding natural feature or features; inclusion of sufficient subquality area to accommodate intensive and wearing uses; inclusion of area in natural or naturalistic condition on spacious scale; inclusion of buffer area to discourage parasite developments; inclusion, whenever possible, of satisfactory year-round habitat for wildlife.

4. That general plans for the whole park development be prepared by competent advisers before construction is begun on roads or other development.

5. That scenic easements be used as a means of protecting surroundings of recreation properties and preventing adverse types of occupancy.

6. That all values involved be carefully weighed in determining the kinds of public use to be encouraged on any State recreation property.

7. That intensive uses of such properties be limited to one or, at most, to a very small number of locations.

8. That administration be kept on a nonpartisan basis, that properly qualified administrative officials and employees be selected, and that administration of parks and related areas be not subordinated to any other branch of conservation work.

9. That State recreation administrative agencies be equipped to render advisory service on recreation problems of political subdivisions of the State.

10. That part of the cost of operation of State recreation holdings be borne by users, through imposition of reasonable fees for exclusive occupancy, for any form of special service, and for rental of recreation equipment.

11. That in every State park a liberal portion of the total area be left completely undisturbed, free from roads, and with only a limited extent of trails.

12. That roads in State parks provide access to points of intensive use, and to one or two points of special interest; that access to other parts be provided by trails; that construction of trunk highways through parks be prevented whenever possible; and that control of road location and design rest with the park authority.

13. That no exclusive-use leases be permitted in any State park, monument, or recreation reserve.

14. That the States be encouraged to provide State trails for the pedestrian, both parallel to and independent of vehicular travel routes.

The potential recreational usefulness of State forest and game lands suggests similar considerations in the case of their development.

The Federal System

The preservation of superlative examples of scenery—including samples of the primeval and historical or archeological sites of national importance—is properly a responsibility of the Federal Government. Since the subjects of erosion, wildlife, and water are being treated in other sections of this report, it is necessary only to indicate that they are extremely important to the subject of recreation. Preservation of the primitive and of historical and archeological sites should be regarded as a Federal responsibility.

Primeval Areas and Their Protection: Primeval areas are defined by the National Forest Service as "tracts of virgin timber in which human activities have never upset the normal processes of nature." Such primeval areas have been set aside in the national forests. But the size of such areas is relatively small—generally from 1,000 to 2,000 acres Speaking purely of biological requirements, it may be said that a primeval area, if it is to remain primeval, should probably be at least one-quarter million acres in extent, and that even an area of 2 million acres in extent may be too small if its boundaries are not properly located; for instance, Yellowstone National Park, which contains little natural winter range for its elk, deer, antelope, and bighorn. However, it may well be that other considerations may militate against the specific designation of an area of such magnitude.

A definition of perhaps more positive character has therefore been suggested, as follows: Primeval areas are unmodified tracts of land with accompanying plant and animal life where normal processes of nature continue undisturbed by man and where all forms of life are given sanctuary. A cut-over area, for instance, might be considered a "wilderness", but not a primeval area. In still shorter form the definition could be: An area where ecological processes are not modified by artificial treatment. A wilderness area is free from man-made roads and conveniences, but a primeval area area contains unspoiled virgin fauna and flora. The one emphasizes kind of travel possible, the other, the type and condition of cover. There is a place for both types of areas in a well-rounded plan for outdoor recreation.

Opportunities for preserving the primitive are greatest on large Government reservations like the national parks and national forests, but in actual practice, because of emphasis on other uses, the opportunities have been lost or diminished.

In the national parks, primeval areas are not extensive but under the law are subject to human use and enjoyment. Since conservation of unspoiled areas is a prime duty of the National Park Service, primitive areas should receive the attention and continuous protection they deserve.

Suitable primitive areas may still be left on Indian lands or on the public domain. Large private holdings should not be overlooked, since through public purchase or acquisition by gift they might be preserved.

Amid the increasing pressure of motor travel, control of road building becomes an important factor in the preservation of primeval areas. A limitation on this danger is found in the fact that only one motorist in hundreds will venture a mile from his car; the rest are amply content with the road, and the museums, lectures, and pleasures of developed centers. There still remains, however, that problem of problems—how to preserve our national parks while we also use and enjoy them.

In two highly specialized types of areas in national parks the primeval is faithfully preserved:

Sacred areas are spaces set apart to safeguard unique features of national parks. No buildings or roads are permitted in them.

Research reserves are areas within national parks or monuments, unmodified in character, administratively protected from entrance, and left undisturbed by man-made development. Their purpose is to preserve permanently representative geologic phenomena and biotic communities in as nearly as possible unmodified condition and free from external influence, that their chararteristic forms shall continue to be available for purposes of scientific investigation and education.

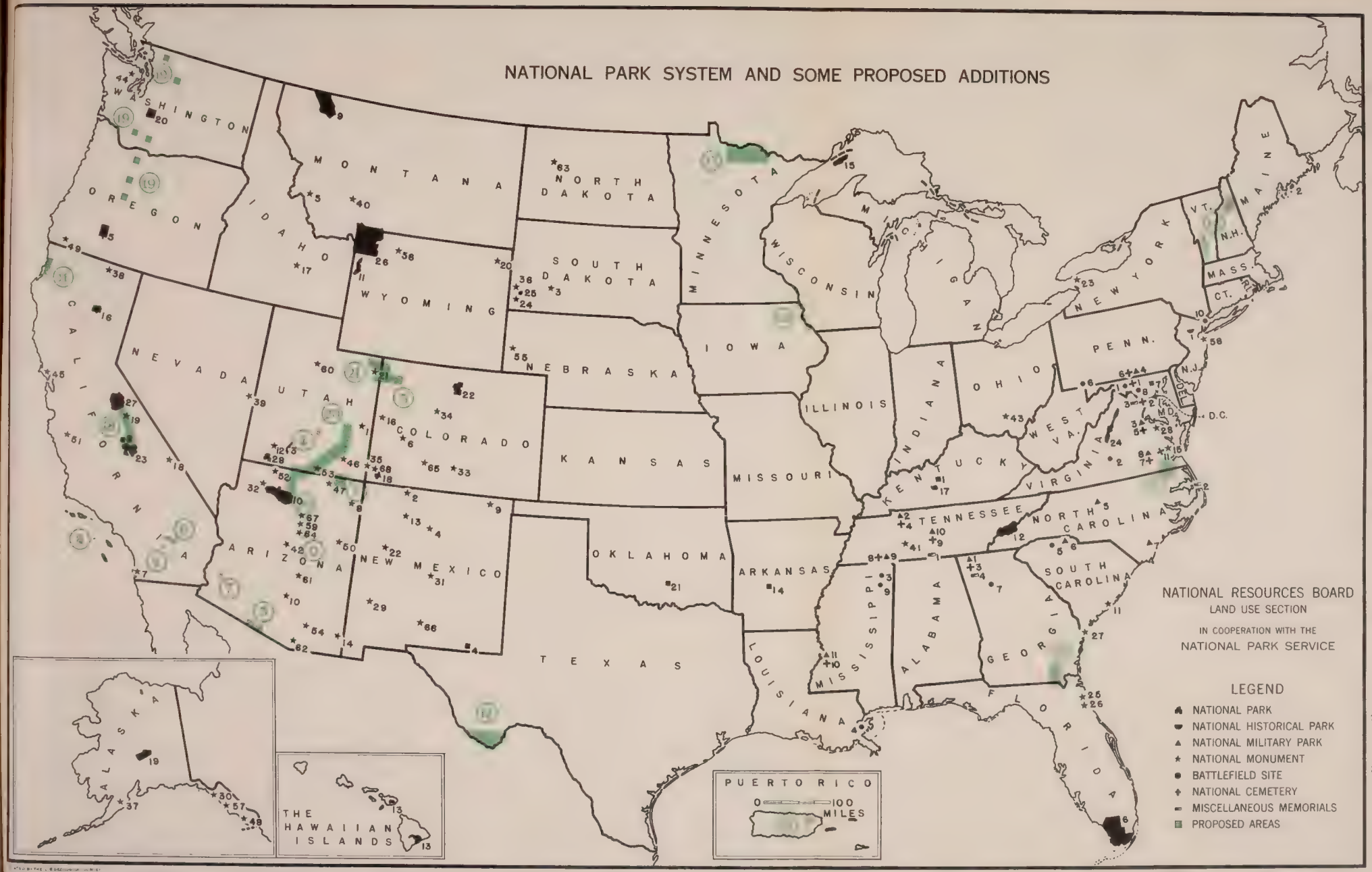
The value of primeval areas, in addition to the mere preservation from extinction of certain biotic forms, lies in their preservation of natural ecological relationships and in their potentiality for recreation of the type consistent with their primeval qualities. Protection of large primeval areas can be accomplished only through the Federal Government. Conservation, i. e., wise use of the primeval areas set aside as such, should not be jeopardized by concurrent or contemplated economic considerations.

Policies with Reference to Areas of the National Forests Not Given Specific Recreational Designation: In recognition of the interdependence of recreational and forest uses, endorsement is given to the policy of leaving strips of timber along roadsides, lakes, and streams, the location of forest roads and trails in recognition of æsthetic values, and the modification of cutting systems to maintain recreational values at the highest standards consistent with silvicultural practice.

Integration of wildlife management and recreational use, particularly in the forests, presents many special problems. There are numerous points where recreational use and wildlife production conflict with each other, but few, if any, insurmountable problems are presented. Stretches of lake shore, for instance, of high value as nesting grounds for waterfowl need to be closed to recreational use during the season of nesting. There should be special provision for wildlife management on areas receiving intensive recreational use, and on areas readily accessible to large numbers of people. On certain large areas the recreational value of wildlife for purposes other than hunting makes it desirable to prohibit shooting to allow the wildlife to become sufficiently tame to permit intimate observation and study.

Historical and Archeological Resources: The United States Government should interest itself directly in preserving a relatively limited number of sites of historic nature. The majority of historic sites, like the majority of scenic and other scientific areas, should be preserved

NATIONAL PARK SYSTEM AND SOME PROPOSED ADDITIONS



NATIONAL RESOURCES BOARD
LAND USE SECTION
IN COOPERATION WITH THE
NATIONAL PARK SERVICE

LEGEND

- NATIONAL PARK
- NATIONAL HISTORICAL PARK
- NATIONAL MILITARY PARK
- NATIONAL MONUMENT
- BATTLEFIELD SITE
- NATIONAL CEMETERY
- MISCELLANEOUS MEMORIALS
- PROPOSED AREAS

PROPOSED AREAS

1. Areas in the Navajo Indian Reservation, Arizona, and adjacent portions of the public domain in southeastern Utah.
2. Palm Canyon, Riverside County, California, a part of the Agua Caliente Indian Reservation
3. An area of organ pipe cactus, in southern Arizona, on the public domain
4. Wayne Wonderland, Utah, on the public domain
5. Yampa Canyon Colorado, on the public domain, referred to below as part of a larger area
6. An area of Joshua trees and desert vegetation southwest of Twenty nine Palms, California; on the public domain
7. An area of native palms in the Kofa Mountains, Arizona, on the public domain
8. Channel Islands, California; five of these eight islands are in Federal ownership, and the three principal islands are in private ownership
9. Meteor Crater, Arizona; in private ownership
10. Indian mounds along the Mississippi River, in Iowa, Minnesota, and Wisconsin; in private ownership
11. An area of redwoods, in the coast redwoods belt, California; in private and State ownership
12. Big Bend Country, Texas, in private and State ownership, adjacent to Mexican territory of high scenic quality and offering an opportunity for an international park.
13. The lake region of northern Minnesota
14. The White Mountains, New Hampshire, and Green Mountains, Vermont.
15. Luquillo Forest, Puerto Rico
16. Okefenokee Swamp, Georgia and Florida, largely in private ownership
17. Dismal Swamp Virginia and North Carolina largely in private ownership
18. An area of the Sierra Nevada, California, to include Yosemite National Park, Kings River Canyon, General Grant, and Sequoia National Parks, and the intervening portion of the Sierra above the commercially valuable timber on both sides of the crest, also to include one or more extensions reaching down to the eastern base of the Sierra
19. An area composed of a number of the volcanic cones along the Cascade Range, in Washington and Oregon, such as Mount Rainier, Mount Baker, Mount St Helens, Mount Adams, Mount Hood, Mount Jefferson, Three Sisters, and such intervening supplemental area or areas as display at its best the virgin forest of the Pacific Northwest
20. An area to include, roughly speaking, the Colorado River gorge from the junction of the Green and Colorado Rivers, Utah, to the Grand Canyon, Arizona
21. An area to include the Green River from Flaming Gorge through Browns Park and Lodore Canyon, the Yampa Canyon project, Split Mountain and Dinosaur National Monument

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EXISTING AREAS

NATIONAL PARKS

Abraham Lincoln
Acadia
3 Bryce Canyon
4 Carlsbad Caverns
Crater Lake
5 Everglades
7 Fort McHenry
Authorized
8 General Grant
9 Glacier
10 Grand Canyon
11. Grand Teton
12 Great Smoky Mountains
13 Hawaii
14 Hot Springs
15 Isle Royale
16 Lassen Volcanic
17 Mammoth Cave
18 Mesa Verde
19 Mount McKinley
20 Mount Rainier
21 Platt
22 Rocky Mountain
23 Sequoia
24 Shenandoah
25 Wind Cave
26 Yellowstone
27 Yosemite
28 Zion

HISTORICAL PARK

1 Morristown

MILITARY PARKS

1 Chickamauga and Chattanooga
2 Fort Donelson
3 Fredericksburg and Spotsylvania
4 Gettysburg
5. Guilford Courthouse
6. Kings Mountain
7 Moores Creek
8 Petersburg
9 Shiloh
10 Stones River
11 Vicksburg

MONUMENTS

1 Arches
2 Aztec Ruins
3 Badlands
4 Bandelier
5 Big Hole Battlefield
6 Black Canyon of the Gunnison
7 Cabrillo
8. Canyon De Chelly
9 Capulin Mountain
10 Casa Grande
11. Castle Pinckney
12 Cedar Breaks
13 Chaco Canyon
14 Chiricahua
15 Colonial
16 Colorado
17 Craters of the Moon
18 Death Valley
19 Devils Postpile
20 Devils Tower
21 Dinosaur
22 El Morro
23 Father Millet Cross
24. Fossil Cycad
25. Fort Marion
26 Fort Matanzas
27. Fort Pulaski
28 George Washington's Birthplace
29 Gila Cliff Dwellings
30 Glacier Bay
31 Gran Quivira
32. Grand Canyon.
33 Great Sand Dunes
34 Holy Cross
35 Hovenweep
36 Jewel Cave
37 Katmai
38 Lava Beds
39 Lehman Caves
40 Lewis and Clark Cavern
41 Meriwether Lewis
42 Montezuma Castle
43 Mound City Group
44 Mount Olympus
45 Muir Woods
46 Natural Bridges
47 Navajo
48 Old Kasaan
49. Oregon Caves
50 Petrified Forest
51. Pinnacles
52 Pipe Spring
53 Rainbow Bridge
54 Saguaro
55 Scotts Bluff
56 Shoshone Cavern
57 Sitka
58 Statue of Liberty
59 Sunset Crater
60. Timpanogos Cave
61 Tonto
62 Tumacacori
63 Verendrye
64 Walnut Canyon
65 Wheeler
66 White Sands
67 Wupatki
68 Yucca House

BATTLEFIELD SITES

1 Antietam
2 Appomattox
3 Brices Cross Roads
4 Chalmette
5 Cowpens
6 Fort Necessity
7 Kenesaw Mountain
8 Monocacy
9 Tupelo.
10. White Plains

CEMETERIES

1 Antietam
2 Battleground
3 Chattanooga
4 Fort Donelson
5 Fredericksburg
6 Gettysburg.
7 Poplar Grove
8 Shiloh
9 Stones River
10 Vicksburg
11 Yorktown

MISCELLANEOUS MEMORIALS

1 Camp Blount Tablets
2 Kill Devil Hill
3 Lee Mansion
4 New Echota Marker

Many units in State highway systems carry a larger than usual percentage of passenger vehicle traffic and offer opportunities for the development of a type of traffic-way somewhere between the parkway and the highway. Frontage and access restrictions might be introduced to provide "Freeways." The scenic easement and other restrictions of roadside development, such as zoning and architectural and landscape control of development in abutting property, might very profitably be used. This idea would apply to highways in thinly populated areas where the natural scenery is of such quality that it would attract visitors, and where the traffic over the highways is a mixture of commercial and recreational travel, the larger percentage being recreational—yet where the total is not sufficient to warrant the construction of two traffic arteries, one for commercial and the other for recreational traffic.

Future National Parks and Additions to Existing Park Areas: A long list of areas suitable for national parks has been prepared by the National Park Service and is included in the report submitted by it to the National Resources Board. These proposals are shown on the map facing page 220. In general, they involve three types of action:

1. Purchase of private property to establish new parks—as in the Shenandoah Park area, or the Everglades. The acts authorizing the establishment of these areas require gift to the Government of the lands involved. In the case of the Colonial National Monument, however, the Government stood the cost of acquisition. There would seem to be need for an established policy in these cases. There are those, for instance, who argue that areas worth making into a national park are worth paying for; while others point to the local benefit from the parks as a reason for some form of local contribution to the project. In the case of the Shenandoah-Great Smoky Parkway, a condition of Federal assistance in constructing the road was gift by the State of the needed right-of-way.

2. Purchase of private property within boundaries of existing parks is seriously needed to secure consistent administration and protection of the parks.

3. Transfers of jurisdiction over areas now administered by other Federal agencies. Questions of transfer of specific areas arise from the natural difficulty of reconciling administrative unity of land areas with special problems of incidental or minority areas which lie directly in the field of some other agency. It has been suggested that a Federal land planning agency might serve in a coordinating capacity in these transfer questions.

As previously pointed out, recreation activities play a large part on many public areas outside of those administered by the National Park Service. Agreement on a unified policy in handling these areas to prevent duplication or unhealthy competition among them is needed, and the experience of the National Park Service may provide useful leadership in securing such an agreement. The Park Service might render technical assistance to other bureaus in the field of recreation just as the Biological Survey serves in the field of wildlife conservation.

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SECTION III
V. POLICIES WITH REFERENCE TO WILDLIFE[1]

Economic and Social Values

Wildlife is as essentially a product of land (or land and water) as is timber, agricultural crops, or domestic livestock. A multitude of kinds, bearing importantly upon human welfare, are especially adapted to every kind of habitat from dense forest and open range to cultivated fields, water, and marsh. It follows, therefore, that wildlife must be adequately provided for in any comprehensive, well-considered plan for land utilization.

The annual meat and fur value of wild animals and birds is estimated at more than $190,000,000 for the entire country. Other economic considerations are receipts from the sale of hunting and fishing equipment, including guns, ammunition, fishing tackle, and clothing, expenditures of sportsmen for transportation, board, hire of guides, and for hunting and fishing privileges on private lands. Total expenditures by hunters are estimated at $158,000,000. Other important economic aspects include the output of the fur-manufacturing industry, the annual expenditures for the maintenance of the numerous and widely distributed hunting and fishing clubs, and the general expenses of tourists and others attracted primarily by an abundance of wildlife, estimated at a total of $254,000,000. It is important also to take into account the incalculable value of wildlife, chiefly birds, as destroyers of insects preying on agricultural crops and forest trees. Some of the above figures, of course, include costs which may not properly be regarded as measures of the aggregate welfare derived from wildlife. Obviously also, a considerable part of the above values would also be credited to recreational uses of land. In the forested areas, it is estimated that three-fifths of the estimated total wildlife value is economic, the remainder recreational. The social values, including the recreational and educational advantages, are more intangible and more difficult to appraise, but none the less real.

Hunting and fishing provide wholesome recreation of a kind obtainable in no other way and afford the variety adapted to the needs and inclinations of our growing population. The pursuit of large game tends to bring out qualities contributing to the virility of our race. A considerable number, to whom the taking of animal life is repugnant, satisfy a natural urge for contact with primitive nature by stalking wildlife to obtain photographs or by making detailed studies of life habits.

The report of the Senate Committee on Conservation of Wildlife Resources (S. Rept. 1329) estimates that there was during the decade ending in 1930 a 400-percent increase in the number of people who enjoy the pastimes of hunting and fishing. It estimates the number of licensed hunters in the United States in 1929 at 7 million and the total of all hunters and fishermen as probably 13 million. The current trend toward shorter hours and fewer days of work will add tremendously to the number of men who seek such outdoor recreation.

Need for Wildlife Management

Recognition of wildlife as a national asset of major importance brings into relief the problem of management. The emphasis on conservation has doubtless been due to the necessity of building up a militant opposition to destructive forces. This danger is not yet past, but conservation should be recognized as a means to an end and not the end itself. The overabundance of game in one region may be a more pressing and difficult problem to solve than its absence or scarcity in another. Game management consists largely in the regulation of numbers in accordance with the food supply, with due regard for other local interests, in producing maximum numbers of desired species, and controlling the number of and damage by undesirable species.

Our wildlife, as a national resource, has nearly everywhere been sadly neglected or grossly mismanaged, with the result that the game population for most species is a very minor fraction of what it was at the coming of the white man, while some species are nearly extinct. The essentials of wildlife management are relatively simple, but exceedingly difficult to put into effect, owing to general apathy, sheer ignorance or misunderstanding, selfishness, misguided sentiment, or politics.

Possibilities and Limitations in Associating Wildlife with Other Uses of Land

Wildlife in a multiplicity of forms has a more or less direct bearing upon other uses of land nearly everywhere. Certain kinds may be highly beneficial, neutral, or seriously interfere with other uses of land. Crows, for example, are beneficial in consuming grubs or cut-

[1] The following persons have contributed material which has been utilized in the preparation of this chapter: J. N. Darling and E. A. Goldman, Bureau of Biological Survey; L. S. Gross and C. E. Rachford, Forest Service

worms injurious to agricultural crops but destroy certain crops, as well as eggs of wild ducks, the breeding of which constitutes a highly important form of marshland utilization. As the tide of civilization and general land occupation moved westward across the continent the greater part of the Plains animals inevitably were wiped out, or resorted to the forests. The final passing of the buffalo and antelope could not have been prevented. The settlement of the vast prairie areas of the Middle West and north into Canada, and their development as one of the greatest grain-producing regions in the world, resulted in the virtual elimination of large sections of the best breeding ranges of our most important waterfowl. The cultivation of land, causing surface absorption of moisture, and the deliberate drainage of so many of the originally innumerable ponds, lakes, and marshes, have wiped out most of the local breeding grounds. Meanwhile, much of the land drained has proven to be of very limited agricultural value. Efforts are now being made to restore some of the 84 million acres that have been drained in the country as a whole. All Federal or State drainage projects should be scrutinized with a view to determining their effect upon the native wildlife, the other water uses and values, and these effects balanced against their value for the purposes already planned.

Pressure of human occupation of the land, therefore, together with almost unrestricted killing by hunters, inroads by predatory animals, and other incidental factors have led to the disappearance of game of many kinds or its reduction to comparatively small numbers over most of its former range. The larger predatory animals virtually disappeared along with the larger game in the eastern States many years ago, but the extent of the destruction of game by mountain lions, wolves, coyotes, and bobcats still remaining in the western States is not generally realized. The greatest predatory animal, however, is man; and some control must be exercised over the too indiscriminate use of modern firearms by increasing millions of hunters if a sufficient breeding stock of game is to be maintained. Hunting of desirable species should be carried on and regulated as a game-crop harvesting operation.

In order to deal intelligently with the problem we must first understand and consider the requirements of the game and all the factors that may result in decreases or increases in number. With these requirements clearly in mind, wildlife values should be measured against other land uses everywhere where there is a serious conflict.

The fact that the forests are the great reservoirs of most of our upland game leads logically to consideration of the relation of forestry to game conservation, with a view to the best use of forest lands. Since the maximum production of timber tends to conflict with the maximum production of game, relative economic and social values and all of the other considerations involved should be carefully weighed in connection with general forest management and the restoration and planting of forests.

The adequate management of big game on national forests presents especial difficulty, owing to the fact that while the United States Forest Service is in general charge the States in which the forests are located claim jurisdiction over the game. The legal status of the game on nationally owned lands has never been definitely settled. Too abundant game may be destructive to forest reproduction and may seriously interfere with the proper regulation of the grazing of domestic stock, another Forest Service function. Proper game management calls for the regulation of numbers, ordinarily by hunting under a limited license plan, the game supply to be maintained with due regard to range carrying capacity and other local interests. Often the necessary killing of game runs counter to the provisions of State game laws. The game should be fostered and made to yield an annual crop to be taken in an orderly way adapted to local conditions. Some States may have what is regarded as competent game administration, but it is obviously impossible for them, subject as they are to changing policies and political expediency, to equal the efficiency of the wildlife service that can be extended to national forests by the Government under plans coordinating all forest uses. Under the present system of divided authority it is very difficult to work out an effective reconciliation of the points of essential conflict.

Wilderness or natural areas, typical of the principal kinds of land surface and landscape aspect, including humid and arid, forested and unforested, should be preserved in the various parts of the country for values that cannot readily be measured in dollars and cents. The fauna is dependent upon the flora, and typical samples of both should be perpetuated. Conditions even approximating the primeval can hardly be maintained anywhere except in wilderness areas of rather large extent. Such a program contemplates, for example, the setting aside for posterity of suitable tracts of such divergent character as the great forest of the Olympic Peninsula of Washington, the Everglades of Florida, and the giant cactus desert of southern Arizona. The areas should be well-rounded units including, as far as possible, both summer and winter range for game, and should function as wildlife preserves of the highest type. In such areas modifying human influences should be limited to such emergency measures as fire and flood control, and the reduction in numbers of large game or predatory animals where these have become excessive. Suitably distributed wilderness or natural areas should be maintained in the national forests, several in the larger national parks might be so designated, and others might be carved from the un-

reserved public domain. It is probable that no typical areas of the long-grass and short-grass prairies that played so prominent a part in our national development remain unmodified, but some might be restored to an approximation of their original condition. Suitable prairie areas would probably have to be acquired by purchase. The present limited system of refuges, Federal and State, designed for the perpetuation of particular species of upland game, such as the buffalo, should be extended to provide more amply for such animals as the antelope, valley elk of California, and the peccary.

Adjustment of the conflicting interests of game and the grazing of domestic stock and the relation of both to predatory animals is a complicated problem on the national forests and the public domain. Large game animals, such as deer, antelope, and elk, often compete directly with domestic stock for forage, and the numbers of either or both may require reduction in order to maintain the food-producing capacity of a given area. Organized predatory-animal control operations are carried on by the Federal Government, mainly on national forest areas and the public domain but also on State and private holdings in cooperation with the western States. The direct objective is the protection of domestic stock for which grazing fees on the national forest are collected by the Forest Service. The work is financed jointly by the Federal Government through the Biological Survey, which is charged with general direction, and by the States or stock associations, which furnish the larger share of the funds required. The national forests are also the principal reservoirs of our larger game, especially deer, from which a heavy toll is ordinarily taken by mountain lions, coyotes, and bobcats.

Hence, predatory-animal control, undertaken in the interest of domestic stock, incidentally extends similar protection to game which only a few years ago was in danger of local extinction. On many of the domestic stock ranges of the West, notably in the national forests of central and southeastern Arizona, deer, antelope, and elk have become overabundant as a result of this protection, and threaten the forage supply for both stock and game. This maladjustment is due partly to the creation of game refuges that are far too large, and lack of adequate provision for the harvesting of a game crop. In such areas, where hunters are unable to utilize the game, predatory-animal repression should be withheld as far as possible without serious injury to local economic interests.

Herds of wild and semidomesticated buffalo range in an isolated part of Yellowstone National Park. These and the larger herds in Canada, together with numerous groups under fence, assure the perpetuation of a species once threatened with extermination. Deer, moose, and black bear now tend to increase where accorded protection, especially in some of our national forests and national parks. A few caribou still persist in an area closed to hunting in northern Minnesota.

Mountain or bighorn sheep, formerly widely dispersed in the more rugged sections of the West, still occur in places in the higher mountains in the national forests and national parks, and in the desert ranges of the Southwest. Usually they are in small bands, with, as a rule, little or no increase, although no killing is permitted under the laws of most States. In some parts of the public domain little utilized by man the causes that led to the elimination of mountain sheep appear no longer to be operative. In some of the rugged, desert mountains, especially of California, Nevada, Arizona, and New Mexico, there is sufficient forage, but ranges cannot be used by domestic stock of any kind, except possibly at certain seasons, owing to lack of water. This, however, could be made available at moderate cost by impounding the run-off at favorable sites. Many such areas, now scarcely utilized for any purpose, could undoubtedly be stocked and developed as excellent mountain-sheep ranges. Owing to the habit of twinning, mountain sheep have a high potential rate of increase. A system of well-administered Federal mountain-sheep refuges would encourage State efforts, and in a few years would afford a surplus for stocking many ranges on which limited hunting could be permitted.

Antelope, regarded by many as the most beautiful and characteristically American of our game animals, have decreased rapidly in most places during recent years. They still occur in parts of most of the Western States, many of the smaller groups, unfortunately, in sections where their extinction is practically certain because of unfavorable local conditions. Antelope have held on with remarkable tenacity but are not likely to survive except on areas where they are accorded special protection. They are reasonably safe in the national forests and national parks, but much of their natural range is on the public domain or lands to which adequate protection or management has not extended. Many are shot by uncontrolled domestic stock interests that resent their competition for forage, and they are apt to be poached upon, especially by settlers on marginal lands. In some sections, however, as in parts of Arizona and Wyoming, protective measures have favored substantial increases. In the Coconino National Forest and adjoining territory in Arizona, in parts of Wyoming, and in other scattered localities, where extinction seemed imminent a few years ago, antelope have increased to thousands. In competition with domestic stock the low-growing food plants are cropped with killing effect and the normal forage supply is so diminished that the antelope are forced to browse on junipers

and other unpalatable trees. Action obviously called for is the drastic reduction of the antelope and regulation of the numbers of domestic stock. However, the general public, accustomed to think of the antelope as a vanishing species, may oppose the killing of surplus animals.

Federal refuges established primarily for antelope in suitable areas on the public domain in several western States would also extend needed protection to mule deer and sage hens. On other parts of the public domain the grazing of domestic stock should be controlled in accordance with the reasonable needs of game, and with a view to watershed protection and the prevention of soil erosion.

Conditions in the eastern forests are now more favorable to the multiplication of deer than they were after settlement of the country. With the earlier decline of the deer, the larger predatory animals that preyed upon them became extinct nearly throughout the region. Moreover, the dense new growth springing up after lumbering operations had removed the virgin forests afforded far more food and cover for game. In marginal or submarginal territory, such as is present in many sections of the Ozark Mountain region in southern Missouri, northern Arkansas, and the Appalachian Mountain region, now virtually barren of game, the forest setting has thus been prepared for the restoration of deer, bear, rabbits, grouse, and wild turkeys on a scale far exceeding the game populations of the same areas before the coming of the white man. If such areas were restocked and properly administered the annual game and fish crop would go far to relieve the general poverty so prevalent in those regions. In general, protection of the forests from fire, as well as the application of other measures necessary to keep the forest productive, contributes to the welfare of wildlife; but to secure maximum values special management plans are requisite to coordinate requirements for timber production with those for production of wildlife. The phenomenal success of forest-game restoration in cut-over areas in Pennsylvania, New York, Michigan, and other States, where large predatory animals formerly present are now absent or scarce, is indicative of what could be done in similar sections in many eastern States.

The preservation of the elk in certain parts of the West is a land utilization problem of importance. The elk is unfortunately very destructive to agricultural interests, and its displacement in densely settled communities was therefore inevitable. Thousands have remained, however, in the wilder parts of the Rocky Mountain region, and in the mountains near the Pacific coast in Washington. They were accustomed to summer largely in the high mountains, and to migrate to wintering areas on the lower mountain slopes and the surrounding plains where there was less snow and where feed was abundant. Occupation of the grasslands at the lower levels for agricultural purposes or the grazing of domestic stock forced many of the elk to remain to winter in the higher and more inaccessible mountains where they suffer pitifully, many dying from starvation and disease in hard winters. Elk of a northern group are fed in winter in Yellowstone National Park by the National Park Service. Those of a more southern group winter in the Snake River drainage, in Jackson Hole, Wyo. Here the Winter Elk Refuge, embracing 4,500 acres of meadowland maintained by the United States Biological Survey, has repeatedly prevented a final disaster. In a solution of the problem of winter range and forage for these elk, about 12,000 acres of additional land are urgently needed. The lands have been tentatively selected, and a bill providing for acquisition has been before Congress for several years. In other areas they compete with domestic stock for winter range. It is possible that provision of a certain amount of such range near the edges of certain western forests would be found worth while. As current practice prohibits hunting in national parks, the provision of open hunting areas for elk should be given careful consideration in connection with plans for park extension.

The original range of the beaver included practically the entire country. It is easily trapped and was eliminated or reduced to small numbers in many areas to which it should be restored and colonies increased as a major asset. Like many other kinds of wildlife, beavers require management; otherwise, the location of their dams may in some places seriously injure other important human interests. In many forested sections food is abundant and general conditions are still suitable for beavers. Under proper management the value of the annual fur crop from this source alone could be made to reach very high figures. Other fur-bearers, such as the muskrat, marten, mink, and raccoon, should also be more adequately managed with a view to developing these neglected wildlife assets.

Private Game Management

The relation of small game, such as rabbits, squirrels, the fur-bearers, and the various species of upland game birds, to private holdings, and especially farm land utilization, is of major importance, owing to the vast extent of the land involved. The cultivation of land brings radical changes in environmental conditions, and these may be either beneficial or harmful, depending on the varying needs of the different classes of wildlife. Farm operations may provide an abundance of food and shelter at certain seasons and leave the game bereft of these prime necessities at other times.

In Europe, hunting from time immemorial has been a sport restricted mainly to the nobility or wealthy classes, who usually assume direct ownership of all game ranging on their large estates. In America, on the other hand, the traditional concept is that ownership of most game, whether on privately owned or public land, is vested in the State or Federal Governments, and that hunting, subject to restrictive laws and regulations including those in regard to trespass, is for all who wish to indulge in it.

The attitude of the farmer toward the hunter has an important bearing in this connection. Farm game, the fur-bearers, and fish, should be regarded as having a potential crop value similar to that of any other product of the soil. Since a farm must be managed for profit, there should be recognition of the fact that the farmer has a kind of proprietary interest in the game attached to his land, and that he is justly entitled to a monetary return proportionate to his efforts in its behalf. He should be encouraged to expect a profit through the sale of shooting or trapping rights, under regulations fixed by the State. The relation of local game, fur-bearers, or fish, to other farm crops of the region should be clearly understood. Rabbits, for example, may be too numerous and injurious to field crops, or to horticulture, in a given locality, while a larger number would be harmless and highly desirable in another place. The food and cover required for wildlife may be provided by less intensive cultivation of land for grain, in conformity with current human needs. In the prairie States many hedgerows and bordering thickets with a highly beneficial windbreak value, and incidentally affording game food and shelter, were uprooted and displaced by barbed wire in order to make the land yield a little more grain in war time. The result has been increased wind erosion, soil exhaustion, and game elimination. Obviously such hedgerows, in conformity with the shelter-belt idea, should be restored in many areas on account of their beneficial effect in the general use of the land. The strip cultivation of land, employed to prevent erosion and as a crop reduction measure, could also be made the means of increasing farm game.

Integration of Policies of Federal and State Governments with Reference to Game

In the case of publicly owned forests, administrative control over the development of land resources in areas of sufficient size to be economically administrated, should be vested in a single administrative agency. This means, in the case of the national forests, that game management and game regulation should be a responsibility of the Forest Service. If this is to be accomplished under State laws, the national forests in each State should be designated as special game districts and the Forest Service given broad regulatory powers, and State laws pertaining to wildlife revised to permit violations of Forest Service wildlife regulations to be prosecuted under State laws. This could be accomplished by designating the forest supervisor as chief wildlife warden of a game district coinciding with his forest. The other course is for the Federal Government to make its own regulations and prosecute violations in Federal courts. Unified areal responsibility of this type is the first requirement of efficient wildlife management on publicly owned forests.

Retirement of submarginal farms within the national forests and resettling the families on better areas and in more compact communities would solve a major game-protection problem, in that a large proportion of the submarginal farmers, by force of economic need, and by isolation from law enforcement agencies, constitute a heavy drain upon wildlife resources, regardless of laws and regulations enacted for game protection.

One of the most important policies for wildlife is the further extension of the system of public wildlife refuges. The general recommendations on this subject are included in section II of this report. The location of specific areas recommended will be given in the more complete report of which the present is a summary.

SECTION III

VI. INDIAN LAND PROBLEMS AND POLICIES[1]

The Wheeler-Howard Act, approved on June 18, 1934, completely reverses the old policy of taking land away from the Indians and destroying their culture, and gives them a chance, for the first time since they became wards of the Government, to make their livelihood in a manner not in conflict with their entirecharacter.

For more than three centuries the white man has driven the Indian from one homeland after another. This long record of forcible reduction of Indian land has had two effects strikingly apparent today. It has left the majority of Indians landless, or with insufficient land, and has largely destroyed the social organization of many of the tribes. Since it was their social organization upon which their ethics, civil order, industry, thrift, and material ambition depended, this policy of cultural destruction has had the effect of leaving the Indians without direction, ambition, or hope, and fundamentally distracted, if not embittered.

[1] The following persons have contributed material which has been utilized in the preparation of this chapter: John Collier, H. R. Crichtfield, Robert Marshall, Harry Nittleton, Ward Shepard, James Stewart, and Walter Woehlke, Office of Indian Affairs; Ray Ovid Hall and Alan Harper, Indian Land Unit, National Resources Board; and William A. Lloyd, Extension Service, Department of Agriculture.

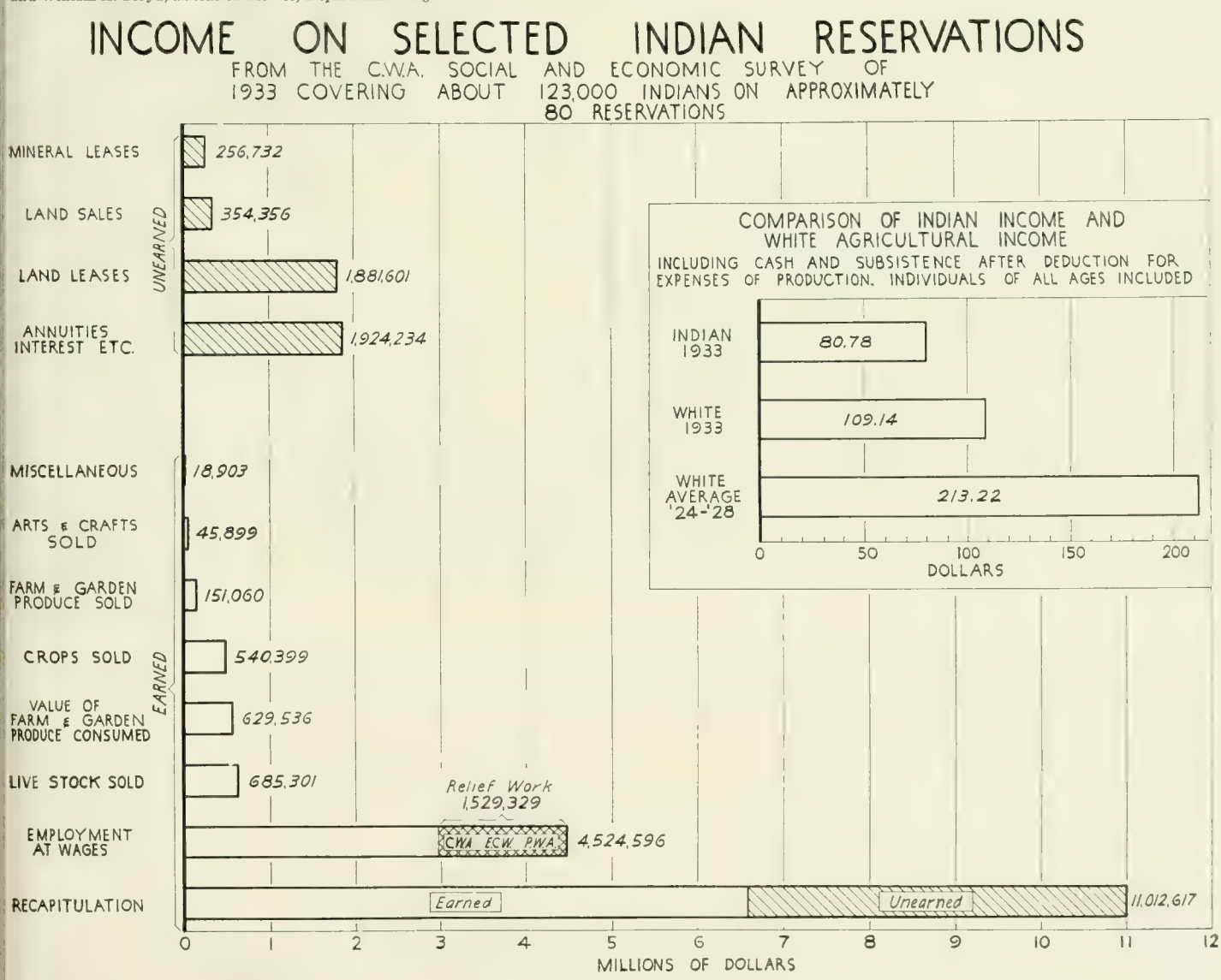

FIGURE 62.—Unearned income on Indian reservations, chiefly from land leases and sales leases and per capita payments from tribal funds, are "out of all proportion." It is many times greater than the commercial value of crops, garden truck, and livestock produced by Indian labor. It exceeds even wage income from private employers. A major objective in Indian land policy is to make it possible for more Indians to work (not lease) their lands, thereby keeping for themselves the income shares of both landlord and tenant.

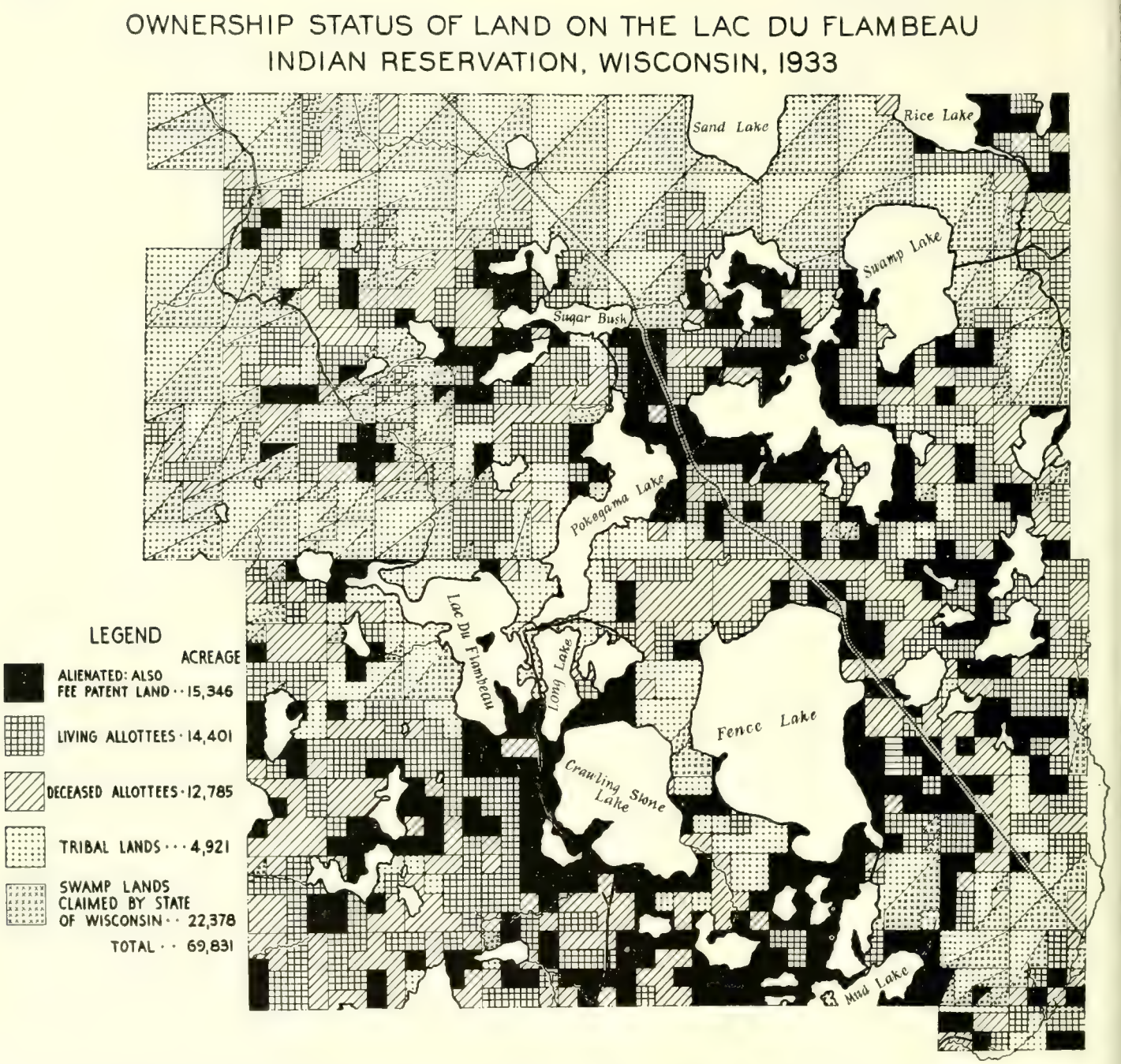

FIGURE 63.—Lac du Flambeau (Wis.) Indian Reservation is an example of a hopelessly "checkerboarded" reservation. The desirable and valuable portions along the shores of the numerous lakes have practically all been alienated to white owners. Remaining in Indian ownership are mainly swamplands and cut-over and burned-over timberlands. The alienated land could not be reacquired except at heavy cost. Without the alienated acreage, it would be fruitless to attempt any program of land consolidation beyond the blocking up of a few tracts for farming land and some of the cut-over acres for milk cows. To satisfy essential economic needs, it will be necessary to go outside the reservation boundaries to acquire lands.

Effects of the Allotment System

The most disastrous single cause of this shattering of Indian morale was the General Allotment Act, adopted in 1887, which for more than 40 years has profoundly affected the life of most Indians and has dominated the whole of the Indian Service. This act provided for the allotment of lands to the Indians in severalty, without making provision for allotment to tribes rather than in severalty in cases where the Indian might prefer tribal allotments, thus endowing him with the property rights and responsibilities of a white person, but with virtually no provision for either the credit or the training to enable him to use his land effectively. It was provided that title to the allotted land should be held by the United States in trust for the Indians for 25 years after the allotment was made, and that allotted lands could not be sold by the Indians during the 25-year period. The courts later held that during the time title was retained by the United States as trustee, the lands were exempt from State property taxation.

As allotment was made, not to a tribe or family but to an individual, the result was a shattering of family and tribal interests. As a rule, the allottee sold his allotment when he received the fee patent. If he retained his land until his death, one of his heirs could obtain title from the others only by buying the land in competition with whites. Vast acreages of allotted land thus passed into white ownership and allotted reservations today are checkerboarded with alien holdings.

Allotment had the further serious result of subdividing to an impracticable point such part of the allotted acreage as did remain in Indian ownership, especially grazing and forest lands where large units are needed for effective utilization. There are cases today where more than 100 Indian heirs are the owners of equities in a single allotment, sometimes as small as 60 acres; and one Indian may possess an heirship equity in 20 allotments.

The heirship tangle makes effective use of the land by the individual Indian impossible. Where the land has not been sold outright, the system has forced the Indian Service to lease the lands and the Indian is thus thrust into the status of a petty landlord who ekes out his living through rental pittances from his land.

When the General Allotment Act was passed in 1887, the Indians owned 138 million acres of land. Today this area has shrunk to about 52 million acres, of which nearly half is desert. The Indians have lost most of their richest farm land to white men. At least 100,000 out of some 328,000 Indians in the United States are today landless, yet have no inclination, training, or ability to live in any way except on the land.

A vivid contrast to the destructive forces of this act is found in those few tribal groups that escaped allotment. In general, they have been self-supporting on their lands, even though in some cases these lands

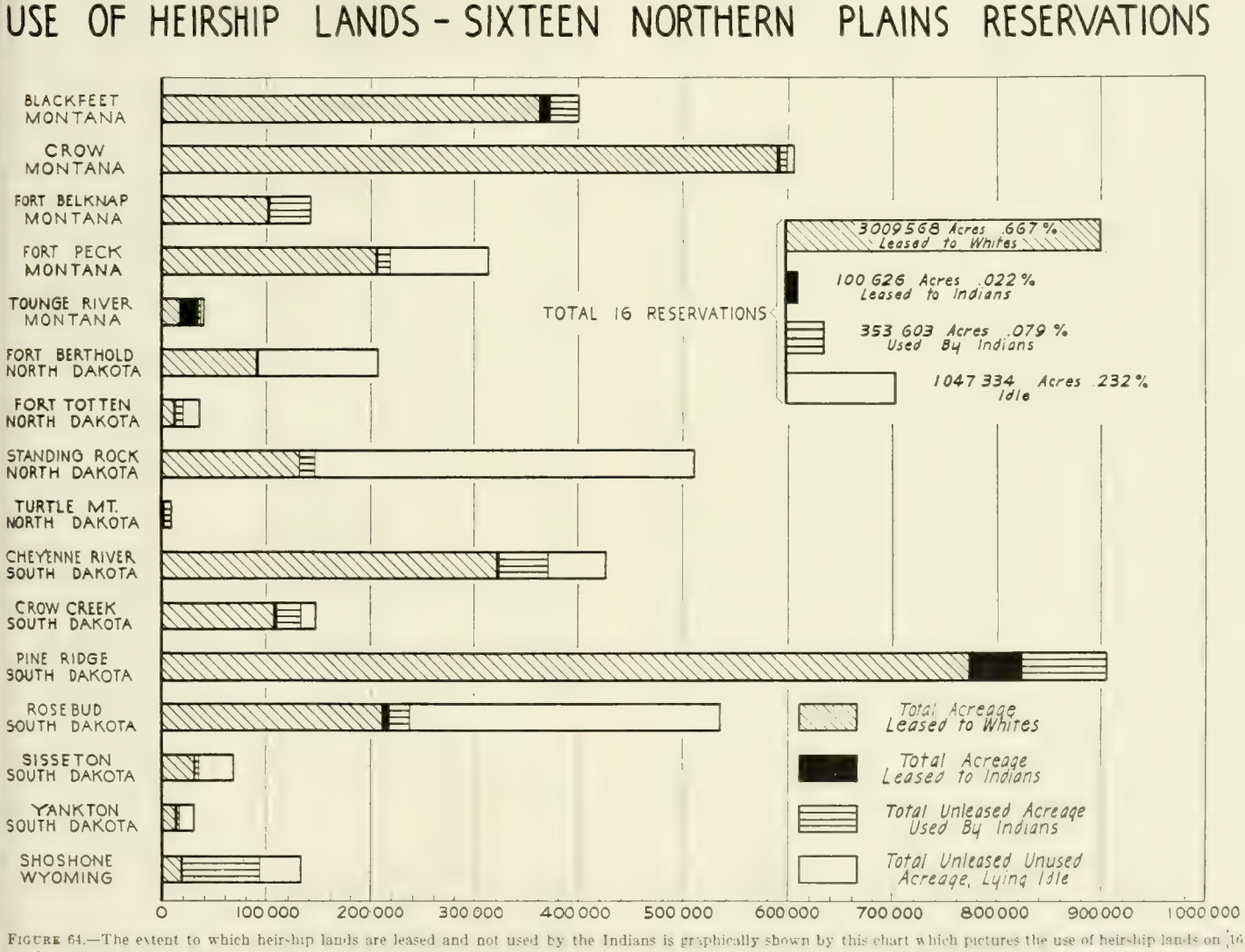

FIGURE 64.—The extent to which heirship lands are leased and not used by the Indians is graphically shown by this chart which pictures the use of heirship lands on 16 Northern Plains reservations. Out of a total of 4,511,131 heirship acres 3,009,568 acres, or 66.7 percent, are being leased to whites. Only 100,626 acres, or 2.2 percent, are being leased to Indians. Another common characteristic of heirship lands is shown in the total of 1,047,334 acres, or 23.2 percent, lying idle, unused by anyone. Predominantly grazing land, the allotments on these reservations can bring the Indian owners substantial benefit only if the allotted land is consolidated into units large enough to permit the Indians to engage in livestock activity, for which they have demonstrated aptitude and ability.

ve been insufficient in area, largely desert, and of lower quality than the average allotted lands.

The policy of the Allotment Act has just been reversed by the Wheeler-Howard Act, but the material and spiritual consequences to the Indian remain as yet unchanged.

Conditions Limiting Efficient Land Use by Indians

The disorganization of ownership brought about by the allotment system is today the most serious handicap to the Indians' use of their land. There are at present about 17 million acres which have been broken down by allotment and heirship. As a consequence, large contiguous blocks have been leased by white men—an undesirable procedure, since this gives the Indians only the rental value of their land and deprives them of the moral stimulus of work and the opportunity to profit from their own labor. In order to promote the use of their own land, the Indians must be given practical vocational training and credit, and further leasing of land to white men must be discouraged. Some solution of the heirship problem should be sought to facilitate the transfer of lands now held in severalty to the tribes. Appropriate legislation may be necessary. A further possible solution may be the organization of cooperative associations to which the Indians could transfer title to their lands now held in severalty, and receive in return certificates of beneficial interest and rights to the use of the land equally with other members of the associations.

Another serious handicap to proper utilization of Indian land is the fact that in the past Indian education has been predicated on the theory that the Indian estate was to be liquidated and that the Indian's future was not to be on the land. His destiny was to be a servant or mechanic living an urban life. As a consequence, Indian education, instead of helping the Indians, has been one of the principal destructive factors in the shattering of Indian morale so tragically apparent today. Statistics show that it has not equipped even 1 percent of the Indians for the competitive life of the cities. Changes are now in process, but they are slow. The system must be reoriented toward a future of landholding and land use by Indians. It must strive to adjust the Indian, both technically and psychically, to the efficient use of his assets and must be directed toward vital problems of Indian life. This principle is already being invoked on the Navajo Reservation where education for adults and children will be centered around the problem of the grazing of sheep and other vital economic and community problems.

Lack of sufficient credit to purchase the necessary livestock, tools, and machinery where desirable, is another deplorable factor in the present Indian land situation. Statistics show that credit extended to the Indian by the Federal Government has averaged through successive years less than $1.50 per capita. Unable to mortgage their trust lands in order to obtain funds with which to utilize them, the Indians today are in urgent need of an adequate and rightly administered credit system. The passage of the Wheeler-Howard Act—providing $10,000,000 as a revolving fund for credit to Indians—is a beginning, but a small one. It is estimated that at least $50,000,000 will be required to provide the necessary homes, livestock, and equipment to lift the Indian people from their present maladjustment to a plane which will provide them with a reasonable opportunity for normal individual and group life.

Attitude of the Indians

That Indians can and will cooperate under conditions in harmony with their racial tendencies is illustrated by the record of the Emergency Conservation program, which has been carried out with amazing success on most reservations simply because group work for community benefit appeals to the Indian social instinct. Another illustration is the former practice of the Comanches of leasing their farm lands to whites in order that they themselves might labor as cattle hands for white stock raisers—an occupation more in keeping with their Indian traditions. (See figs. 62 and 64.)

Labor opportunities for the Indian of the future must follow relatively simple lines, such as subsistence farming, stock raising, logging, and fishing instead of routinized lines of intensive commercial agriculture or factory work. In almost every tribe, despite the destructive tendencies of white domination, there are still powerful group forces. The Wheeler-Howard Act will strengthen these forces by its recognition of self-determination and by its placing of far greater responsibility in the Indians' hands. Through these forces the Indian can be stimulated to perform work necessary to meet his community needs.

There is a sharp difference between the wants of those Indians who still retain a large measure of their original tribal culture and of those whose tribal institutions have degenerated. The needs of the Indians who still retain their tribal culture are modest when compared with white material standards. These Indians have a fundamentally different set of values from white men. They use their bodies rather than machines; they produce their own primitive houses, utensils, and arts, and their life is an expression of their community.

When considering those Indians whose tribal institutions have degenerated—and these amount to two-thirds of the total Indian population—the policy should be to provide them with enough land and facilities to make the attainment of a white man's standard of living possible, provided they will work as effectively

as white men work and consume with similar economy. Should they choose to work intermittently, with slower rhythm and less thrifty use of their income, they could not reasonably ask to be provided with the land and other conditions requisite for a white man's standard of living.

The belief that the Government supports the Indian has long deluded the general public, as well as the Indian himself. The Indian Service, it is true, has been making motions, under terrific handicaps, to feed, clothe, and shelter the Indians, but the performance of these services has been so woefully inadequate that the Indians have never attained even a tolerable standard of living under white paternalism. (See fig. 62.)

The delusion, however, has been in some ways as harmful as the reality would have been. Thousands of Indians today believe it to be the Government's duty to support them. It is an essential feature of the present Indian land policy that the paternalistic service, real or simulated, must be terminated as rapidly as possible, and that Federal activity hereafter be conditioned upon active participation by the Indian beneficiaries and upon measurable sacrifices by them.

By giving back to the Indians a small fraction of the immense acreage which has been taken from them by force, by supplying them as rapidly as possible with greatly increased credit facilities, a type of practical education adapted to their needs, a method by which their present divided landholdings can be blocked into units of economic size, and a system through which they may use their lands themselves instead of leasing them to whites with great economic loss, the Indians will at last be provided with the long-needed opportunity to attain a reasonable standard of living.

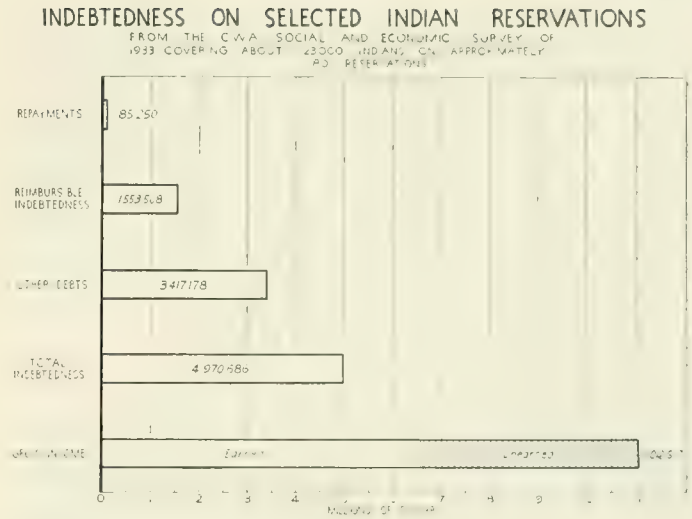

FIGURE 65.—Indians make but limited use of credit, partly because of the trust status of most of their lands. By pledging their unearned income as security against borrowed capital goods, they could borrow perhaps 10 times as much as they now owe.

Basic Considerations and Assumptions in Estimating Land Requirements

How much land will the Indians require to support themselves on a reasonable standard of living, assuming that the necessary capital for the development of the land will be made available, that the Indians wholeheartedly cooperate in using the land themselves, and that their efficiency in both production and consumption will be equal to that of their white neighbors?

It is recognized that such assumptions are somewhat extreme, but they give us, as a point of departure, the theoretical minimum needed to support the Indians on the land on the standard of the rural white population before the depression. In computing the immediate and most urgent needs of the Indians, this theoretical minimum will be reduced by practical considerations, such as limitations of money to buy land, lack of land to buy, the competing needs of the white population for land, the varying capacity or desire of Indian tribes and individuals to use the land, the shortage of capital to develop land, and limitations of the Government in reorienting and financing an adequate Indian education system.

To answer the question asked above, it is necessary to balance the needs of Indians against their potential productive capacity, both in subsistence and cash, if their present resources were fully developed. Calculations to establish this balance have been made and checked on the reservations by men thoroughly familiar with land conditions in specific vicinities and with the needs of Indians in their particular areas.

Estimates have been made for every existing reservation, covering subsistence and cash required by the enrolled Indians to attain a standard of livelihood approximating that of the average rural white man before the depression. In the case of landless Indians unattached to reservations, the need for land has been estimated by the same general method. The potential net value of both the subsistence and cash which each reservation could produce from the full development and intensive use of every present resource of land and labor has then been estimated, and to this figure has been added the average annual cash income which the Indians have been making from their wage work. The sum gives the total monetary value of what the Indians of a reservation can produce if they fully utilize all present resources on an efficient level.

Where this productive capacity is greater than the estimated requirements on a reservation, the Indians have enough land to attain a reasonable standard of living, except in special cases. Where a given tribe has a surplus of land, it cannot, of course, be deprived without its consent or without compensation for vested rights acquired by treaty and law any more than white owners of large tracts of land could be so deprived.

Moreover, on reservations showing a surplus, many individuals have no land, and, under existing law, they cannot be supplied with land from those having a surplus. On the other hand, when the requirements are greater than the productive capacity, additional land will be needed to provide a production which will balance the requirements for such reservations.

Land acquisition programs have been formulated for the reservations with a deficit in potential production and for those reservations on which there are landless Indians.[2]

Present Needs of the Indians for Land

The detailed figures for the annual requirements and the potential productive capacity of each reservation and each band of landless Indians will be shown in the complete report. These figures have been summarized for the entire country in table 27.

TABLE 27.—*Estimated net annual requirements and net annual productive capacity of the Indians, assuming no leasing of Indian lands*

Estimated net requirements	$81,289,191
Estimated net productive capacity:	
Crops	25,405,832
Livestock	13,481,088
Forest products	5,717,039
Mines	521,033
Oil and natural gas	5,519,386
Water power	779,340
Fish	240,465
Game	170,927
Furs	87,160
Wild-plant products	393,673
Recreational developments	354,950
Handcrafts	1,373,487
Poultry	2,772,702
Dairy products	6,426,648
Wages from outside reservation	4,124,864
Total	67,368,594
Estimated deficit of productive capacity	13,920,597

Table 28 contains tentative estimates of the areas and approximate values of the land required to eliminate the large deficit in productive capacity. "Value" should not be confused with "cost" since a part of the land needs of the Indians may be met by granting Indians privileges of use on other Federal lands, such as national forests, national parks, and public-domain grazing districts. Moreover, future purchases of land under the general land program of the Federal Government, as, for example, for the creation of national forests, national parks, and game refuges, and submarginal land which is to be taken out of cultivation, might provide in the aggregate a large amount of land which the Indians might use in one or more ways or on which Indian labor could be employed, and small colonies of Indian workers be established. Of the total area of 9.7 million acres listed as "urgent", possibly as much as 2 million acres could be supplied by permitting Indians to use existing Federal lands or proposed purchases by Federal agencies other than the Indian Service, provided the programs of these agencies are properly coordinated.

For the purpose of a practical program, the land needs listed in table 28 are divided into two classes, "urgently needed" and "deferred." The sum total of the two gives the estimated area required to raise the Indians to the standards of living of rural whites before the depression. Under "urgently needed" are included the lands required to permit all Indians—including enrolled and unenrolled,[3] landless individuals and bands, and individuals and tribes with insufficient land—to reach a mere subsistence level above the verge of starvation and the dole. The economic plight of most of these Indians is desperate and they constitute a serious relief problem that at present is met inadequately or not at all. Under "deferred" are included the additional lands that should be provided to enable the Indians as a group to attain the modest standard of living of the rural white population before the depression. The estimate of land needs in the table are, to repeat, tentative. They are subject to revision after further intensive field study of the local land and economic problems of each reservation.

TABLE 28.—*Additional land needed by Indians and estimated value thereof*

Class of land or other resource	Urgently needed		Deferred needs	
	Acres	Value	Acres	Value
Agricultural (nonirrigated)	631,535	$15,161,180	874,158	$14,137,310
Agricultural (irrigated)	83,299	4,800,410	20,445	1,963,070
Range	7,171,778	21,405,750	14,063,735	33,994,857
Forest (including cut-over)	1,819,878	8,413,473	916,694	3,407,300
Water development		10,270,000		15,730,000
Total	9,706,490	60,050,813	15,875,032	69,232,537

The table indicates that a minimum of about 9.7 million acres of land is urgently needed; but, as already stated, and as will be explained later, not all this land need necessarily be purchased, but may in part be supplied from other Federal lands. Toward this program, the sum of $5,000,000 has already been made available to the Indian Service for the purchase of submarginal lands for Indian use, under the submarginal purchase program. With the appropriation of $2,000,000 a year which has been authorized by the Wheeler-Howard Act for land purchase, it would take many years to acquire that part of the urgent land needs that can be acquired

[2] The land requirements of each reservation are mapped and described in the full report.

[3] Among unenrolled Indians are included only those of a half degree of blood or more.

only by purchase. It is strongly urged, therefore, that a new program be adopted which will make it possible to acquire all the urgently needed lands (either through purchase or through granting rights of use on other Federal land) within the next 7 years, and the whole area as rapidly as possible thereafter.

The total of $129,000,000 required for both classes of land, together with water development, may at first glance seem like a large amount to spend on reestablishing Indians on a reasonable basis of living. Yet the United States Government has spent $1,047,032,149 during the last 50 years to care for Indians on the short-sighted basis of paternalism.[4] If the Government will invest a sufficient sum to provide Indians with the opportunity to become self-supporting, instead of forcing them to continue to depend on doles, there would be a saving to American taxpayers as well as an opportunity for the Indian to work out a decent standard of living.

Accurate statistics indicate that there was a 28 percent increase in Indian population between 1910 and 1934. The Indian population at present is estimated at 327,958. It is reasonable to predict that within the next quarter century the total Indian population will increase by approximately 100,000, of which large numbers will be predominantly of Indian blood and will live on the land. (See fig. 66.) However, once the present Indians are given land, credit, practical education, and the right psychological and social background, they should themselves take care of the land needs of their offspring. The policy of the Government should be to give them an opportunity to get started, not to provide for their requirements indefinitely.

How Additional Land Can be Obtained

A part of the total land requirements of the Indians may be met, not through purchase, but through giving them rights of use in certain national forests and national parks, and on portions of the public domain. Considering the acute need of Indians for more land, they should be given the same proportionate use of such public lands as the white population. Insofar as this might operate to deprive whites of land which they have customarily used, they should be compensated and aided in finding other opportunities of earning a livelihood. There are a few relatively small areas of national forest land that might well be turned over outright to Indians, and there are strategically located tracts of State land which the Government should acquire for Indians by purchase, exchange, or otherwise.

Certain white-owned grazing lands which have been seriously overgrazed could be acquired for Indians

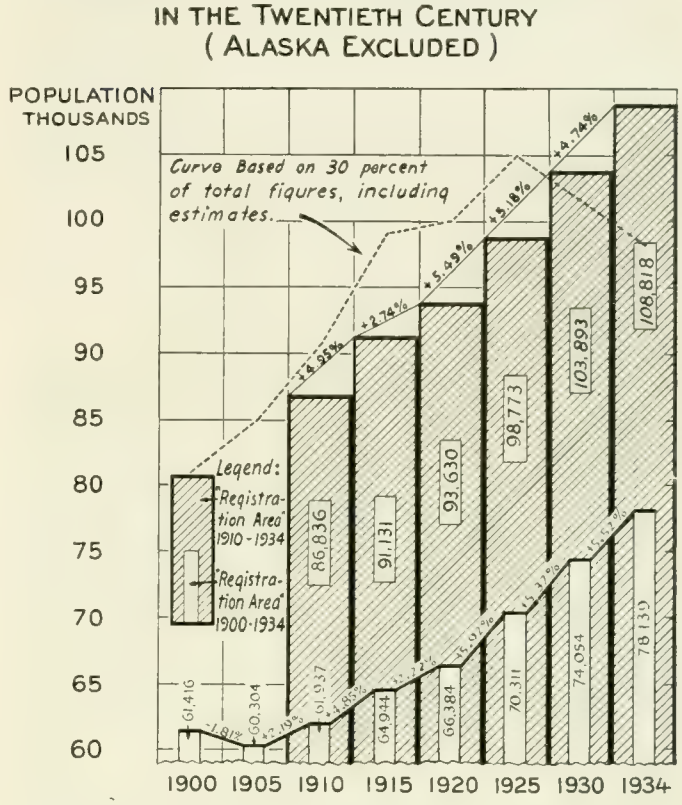

FIGURE 66.—The annual figures of the Indian Office for population on most reservations are rough estimates corrected by actual counts only when special administrative need arises. To compute population trends it was necessary to segregate the reservations or bands for which actual yearly counts were apparently made. The result was two newly constructed "registration areas", covering respectively 64 reservations or bands from 1900–34 and 92 reservations or bands from 1910–34. The samplings indicate that from 1910 to 1930 enrolled Indians increased at almost precisely the same rate as total Negroes of the United States. Indian population probably declined, at varying rates, for about three centuries prior to about 1905. Increases since then have been largely or wholly of mixed bloods.

now and allowed to recuperate for several years until the Indians have bought or raised the animals to stock them. Indeed, a considerable part of the entire acquisition program, particularly of grazing and forest lands, could be taken care of through the Government's submarginal land purchase program. Assuming that this program will continue for some years, it should be carefully correlated with the Indian land acquisition program and thus, while reducing commercial cultivation or potential commercial cultivation of low-grade farm lands, aid the Indians to round out their range and forest units.

It has been proposed that certain landless Indians, notably in Wisconsin and Minnesota, might be colonized on National or State forests, either existing or to be created by purchase. Many such areas have been severely damaged by fires and destructive logging, and require much work at Government expense to protect them from fire and to restore them to a con-

[4] The Government has also, through its mismanagement, permitted or forced the Indians to lose 91 million acres of land, worth at least half a billion dollars and probably very much more.

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dition of reasonable productivity and beauty. This labor could be performed in part by Indians. They would be doing productive public work, earning their livelihood in a manner natural to them, and at the same time reducing the scope of the otherwise necessary land acquisition program. The part-time income they would thus receive might be augmented by establishing subsistence gardens, raising poultry and dairy cows, making maple sugar, hunting, trapping and fishing in season, and guiding and caring for tourists. However, this program can be worked out only in relation to the equitable needs of nearby white people dependent on such opportunities for employment.

Submarginal agricultural land should be retired from crops and be planted with trees or converted to range. Considerable submarginal farm land, now owned by whites, which the Government is buying, could be used by the Indians as range, and some of the lands are already being acquired for this purpose.

The Indian agriculture planned under the new land program will furnish chiefly subsistence and stock feed, and will not add appreciably to farm products placed on commercial markets. It need not, therefore, be considered a material factor in crop overproduction.

The bulk of the land required must necessarily come through purchase from the present private owners. Such land may include alienated areas within the reservation, and solid blocks of white-owned land outside the boundaries of existing reservations. In many cases, of course, the present white occupants must be aided in reestablishing themselves elsewhere, or the result will be the substitution of one evil for another. This difficulty can be met in part by the present submarginal purchase program as a whole, since the program contemplates resettling the owners whose land is purchased and at the same time using their submarginal farms to block up solid range units in existing reservations.

The withdrawal of this private land from tax rolls, coupled with similar proposed withdrawals by other public agencies, may tend to intensify the serious tax situation in many counties. On account of increasing tax delinquency and other forms of fiscal disorganization, a complete reorganization of rural financing and a reconsideration of the relation of local government to Federal taxation is imminent in any case; and the withdrawal of lands for Indians will be only a trivial factor in the total situation. Moreover, in the case of Indians the Federal Government either assumes the entire cost of the public services (such as education, health, and road construction) customarily assumed by local government units, or makes contracts with local government units and pays the cost. The loss of local taxes is thus wholly or largely offset by these Federal expenditures. It might still be argued that this Federal subsidy gives the Indians a large advantage over the white population. The program of economic rehabilitation, however, should enable the Indians gradually to assume a part of the burden of their own public service.

Erosion Control

In the past most Indian reservations have been badly overgrazed. Grazing regulation has tended to improve this condition during recent years, but there are still too many animals for the range in all sections of the Southwest, where Indians have for decades been urged to stock the ranges far more heavily than they could possibly stand. This overgrazing has resulted in such severe erosion that millions of acres of Indian land will shortly have to be abandoned unless the stock is drastically reduced and various physical control measures are inauguarated. In cooperation with the Soil Erosion Service, such steps are being actively undertaken on the Navajo Reservation. They should be begun on at least 40 other reservations. As a first step, the Soil Erosion Service has made a preliminary survey of erosion on Indian reservations, the main facts of which will be presented in the supporting data submitted with this report.

Restoration of Fish and Game

At present most reservations are badly overhunted, overtrapped, and overfished. It should be possible, however, to interest the Indians in developing programs of restoration and conservation which will give to fish and game on many reservations something of the economic importance which they had in primitive Indian life. To accomplish this end it will be necessary to acquire additional land for game refuges, to end the jurisdictional friction between the States and reservations regarding game-law enforcement, and to aid the Indians to return to and to improve upon the conservation practices which characterized them before white men upset their economy. Close cooperation between the Biological Survey, the Bureau of Fisheries, other interested Federal agencies, and the States will be required to make this program a success. Such cooperation was definitely required by the Game Coordination Act of 1934.

Indian-Owned Timberland

Indians today own about 8½ million acres of timberland, bearing a total volume of about 25 billion board feet. While this is roughly only about 1.5 percent of the total volume of standing timber in the United States, it assumes a special importance because, unlike

most timberlands in the country, it serves as the home for large numbers of people. In the past Indian timber has generally been sold to white operators and the Indians have lost wage work and the profits of operation. Section 6 of the Wheeler-Howard Act directs the Secretary of the Interior to make rules and regulations for the operation and management of Indian forests on the principle of sustained-yield management. These regulations are now being drafted. Together with the policy of employing Indian labor for forest operations, they will naturally insure a great opportunity for the employment of Indian labor and will stabilize forest income in the future.

Forest lands on which timber is so slow growing and inaccessible that it cannot be profitably grown or harvested, should be reserved for soil and water conservation, grazing, harvesting of native plants and berries, fish and game production, and recreational development. Consequently, where there is any doubt about the commercial desirability of developing a given tract of timber, it should be left for these other purposes.

The Future Indian Civilizations

The word "civilizations" is designedly used in the plural. There will be, as there have been, numerous and divergent Indian civilizations. It can be stated that those tribes which have in a measure preserved their ancient cultures will, if reasonably assisted, continue as distinctive communities wherein the utilitarian interests will be blended, as they have been in the past, with esthetic, ritualistic, and mystical interests. There is enough experience to make it possible to predict that those aboriginal cultural groups can appropriate modern technologies, use to some extent the modern tools of business activity, and interact with the cultural life of white America without losing their racial culture.

With respect to those Indians whose tribal culture has degenerated, the future is largely that of rural America, but of a rural America organized into community corporations and employing many devices of cooperative production, distribution, and living. However, there still remains, even among these Indians, a deep and extraordinarily persistent sentiment of Indianhood which may yet result in a significant revival of valuable tribal loyalties and customs.

The Indian is entitled to work out a satisfying life in his own mode. If he can survive with as much as possible of his own cultural birthright, the total civilization of the United States will be made richer and more stimulating.

SECTION III
VII. POLICIES WITH RESPECT TO THE PUBLIC ACQUISITION AND OWNERSHIP OF LAND[1]

National and State-Owned Lands

In previous sections of this report, various suggestions have been made for increasing the area of land in Federal and State ownership. It is now desirable to consider what result these suggestions would have in enlarging the aggregate of publicly owned land.

The area of land in national ownership exclusive of the territories is divided into two general classifications, public domain and national reservations. The public domain consists of: (1) all lands which are or may, when surveyed, become subject to entry; (2) lands which are temporarily withdrawn from entry pending further disposition; and (3) lands on which there are pending and unperfected entries.

Constant changes are being made in the withdrawn lands and probably 50 percent or more of the pending and unperfected entries will never go to title.

Public domain:	*Acres*
Unreserved and unappropriated	[2] 165, 695, 479
Withdrawals pending further disposition (estimated net)	30, 442, 832
Pending and unperfected entries	24, 040, 779
Total	220, 179, 090

National reservations are lands which have been permanently withdrawn from the public domain or acquired by purchase, exchange, or donation. With some small exceptions they are not subject to sale or alienation and are generally considered as reservations in perpetuity.

National reservations:	*Acres*
National forests	[3] 145, 843, 707
National park areas	9, 308, 609
Wildlife refuges	[4] 1, 878, 943
Indian lands (tribal, heirship, and allotted but unalienated)	52, 142, 046
Military, naval, and similar reservations (estimated)	1, 000, 000
Total	210, 173, 305
Total of all nationally owned lands	430, 352, 395

[1] The following persons have contributed material which has been utilized in the preparation of this chapter: Paul W. Gates and Kenneth H. Parsons, Land Policy Section, Agricultural Adjustment Administration; E. O. Wooton, Division of Land Economics, Bureau of Agricultural Economics; Wade E. DeVries, E. A. Foster, and L. F. Kneipp, Forest Service.

[2] Of this, 80 million acres are subject to withdrawal for grazing districts under the Taylor Grazing Act.

[3] Includes approximately 4.3 million acres which have been approved for purchase and the funds for which are available but the actual purchase has not been consummated.

[4] Includes approximately 1,029,000 acres which are public-domain lands withdrawn for reclamation purposes and are part of the "withdrawals" listed above. Also includes 1,252 acres which have been approved for purchase.

The above total will also be increased by the acquisition of certain additional areas already authorized and provided for. There are approximately 6.8 million acres to be added to the national forests under special allotments made by the present administration. Under the submarginal land program, 5 million to 6 million acres are being acquired, which are to be assigned to various State and National agencies for administration. One hundred thousand acres are being purchased by the Tennessee Valley Authority and perhaps ½ to 1 million acres are in process of acquisition by the Indian Service under the Wheeler-Howard Act.

The State-owned lands include areas which have been received as donations from the Federal Government or which have been acquired through purchase, exchange, donation, or tax delinquency. Because of differences in methods of classification, and incomplete and, in some cases, total lack of information, it is impossible to do anything more than estimate the areas of land owned by the States. On the basis of incomplete data it is estimated that an aggregate of nearly 70 million acres of land are in State ownership, of which 2.9 million acres are in parks, 5.8 million acres in forest reserves, 5 million acres—a modest estimate—are tax-delinquent lands to which the States have already acquired the title,[5] and 56,132,000 acres are lands which were granted by the Federal Government for education, swamp drainage, and other purposes. This last figure also includes Texas education lands which the Federal Government never owned, and some other small miscellaneous items. Most of the 56,132,000 acres is in the 11 major public-land States and Texas.

Summary of Aggregate Area Proposed for Ultimate Public Ownership

The aggregate areas proposed by Federal agencies for Federal and State acquisition in the present report may be summarized as follows:

	Federal	State
Parks	22, 691, 391	7, 000, 000
Specialized wildlife refuges	38, 000, 000	2, 000, 000
Forests	131, 200, 000	52, 800, 000
Indian lands	24, 963, 080	----------

While the ultimate acquisition of about 75 million acres of submarginal farm land is herein recommended, it is believed that most, if not all, of it will contribute

[5] As shown later, the aggregate area on its way to State ownership through tax delinquency and the area in county ownership, or destined to become county ownership through delinquency, is far greater.

to the rounding out of some of the categories of the above table. As substantial and undetermined portions of the lands recommended for acquisition are now a part of the public domain, it is difficult to estimate as yet the total amount of land which is contemplated for State or Federal purchase, or the ultimate acreage of land which would be in public ownership should all of these acquisition programs be consummated.

Need for Integrating Programs for Public Land Acquisition

There are ten or a dozen land acquisition or administration units in several Federal departments and independent establishments. With the exception of the General Land Office, all of these Government divisions are actively engaged today in acquiring land through purchase, exchange, donation, or transfer from other Government agencies, and a number of them are recommending herein a great expansion in public-land acquisition. At the same time some of the State, county, and local governments are purchasing or acquiring through tax delinquency substantial areas, some of which may well be employed for public parks, forests, reservoirs, and other purposes.

The land acquisition policies of the various bureaus of the Federal Government have hitherto been largely independent of one another, and there has been little or no attempt to relate them to one another or to the land policies of the States. Coordination among the various land-administering bureaus has long been needed, but this need has been emphasized recently by the emergence of new policies, such as the submarginal land policy, the various settlement policies, the soil erosion program, and by the impetus given to the national forest purchase program by allocations of emergency funds. The need for coordination is greatly increased by the fact that there are extensive areas of "idle" land, most of it tax delinquent, not peculiarly adapted in many cases to fulfilling the existing objectives of various public agencies. Much of this land is not of outstanding value for forests, specialized game refuges, or for parks in the ordinary sense, but it may be serviceable for the several purposes of timber production, protection of soil, regulation of run-off, game, and outdoor recreation. The specialized land acquisition policies of the various existing Federal and State agencies are in general not well adapted to coping with the problems of idle land as a whole. It is now being dealt with only in piecemeal fashion.

A program for establishing this desired coordination in public land acquisition activities is suggested in a following section.

There are five principal methods used by State and National Governments in acquiring land: Purchase through voluntary sale, condemnation and purchase, exchange, gift, and retention of tax-delinquent lands. As the last method is being discussed later, only the first four will be taken up here.

The most common method of acquiring large areas of land is through outright purchase, a simple process in which the Government bargains with the landowner and, if an agreement can be reached, the transfer is made, the Government acquiring the same rights in the land as were held by the previous owner. This method of acquisition is a mutual process in which both parties must be satisfied, and it does not arouse local feeling as does wholesale condemnation of land through the use of the right of eminent domain. Dependence can be placed upon this method of land purchase when there is no great urgency for acquiring land and when the Government can wait until the owner is willing to sell at a fair price. It is not wholly satisfactory, however, where an extensive program of land acquisition has been undertaken and where it is necessary to block up solid tracts in order to carry out the purpose of the program successfully.

The Federal land purchase program began in 1911 with the enactment of the Weeks Act, which authorized the expenditure of certain moneys for the acquisition of forest lands. Since then additional money has been appropriated or allocated for the purchase of lands for forestry purposes, migratory bird refuges, Indian reservations, and for retirement of land from agriculture. Congress has specified that consent of the State must be obtained for the purchase of land for national forests and migratory bird refuges.

The right of eminent domain has been used infrequently by the Federal Government and rightly so, because its general use would unquestionably stir up local opposition. When it has been necessary to secure solid blocks of land, State and Federal Governments have resorted to this method of preventing owners from holding up the program. Thus the Federal Government has employed the right of eminent domain to acquire solid blocks of land for wildlife refuges where any remaining alien ownership might defeat the purpose of the program. In such cases, court procedure is resorted to, a fair appraisal of the land is made by a local jury, and the award is based upon this appraisal.

The policy of exchanging public for private lands to complete Government control of an area has been widely used by the National Forest Service and to a less degree by the National Park Service. When the national forests were created, they contained much privately owned land, the existence of which prevented the most efficient and best possible development of the forest areas. Recognizing the need for consolidating national forests, Congress has passed 56 laws of a more or less special character authorizing the exchange of public for private lands, and under these laws 1,547,606 acres have been acquired in exchange for 451,322 acres and a large amount of national forest stumpage. The chief weakness of most of these exchange laws is that

they have required the transfer of land at the time within the national forests, instead of permitting the exchange of public domain lands outside the forest area for privately owned lands within the forests.

The Taylor Grazing Act authorizes the exchange of public domain land outside the grazing districts for privately owned lands within them, a feature which, if pressed, will permit the consolidation of most of the public lands within the districts.

Donations of land to the Federal Government have been important, and most of them have been made for park purposes. Large areas in the Jackson Hole country in Wyoming, the Yosemite, Great Smoky, Shenandoah, and Lafayette National Parks have been donated or offered to the Government by States or individuals. Smaller donations have been made to the national forests. Recent developments indicate that donations will be of more importance in the future.

Policies with Reference to Adjustments in Local Government and Finance

The influence of public acquisition and ownership of land upon local government and finance will vary greatly in different sections of the country, depending on whether the people are now widely scattered on a large area or are living in compact communities; whether the present public expenditures are high or low; whether the land is now tax delinquent or tax paying; and will vary with the amount of land that is acquired in a given community by public agencies. In certain areas the probable results of a program of public acquisition can be rather clearly defined. In the thinly settled cut-over country literally hundreds of high-cost schools and thousands of miles of roads could be eliminated by a public purchase and resettlement program; here tremendous savings are possible. At the other extreme are large poverty-stricken rural areas with a dense population, little property, and a minimum of public expenditures. In such areas, absolute governmental expenditures are not likely to be reduced by public purchase of land and resettlement of the people; relatively, the burdens of government will likely be reduced by the achievement of the projected rehabilitation of the people. But, in general, the land acquisition program will affect the various sections of the country so diversely that the public policy to cope with the problems of adjustment must be formulated out of and as a part of the general experimental process involved in the program.

However, in practically all areas loosely termed marginal or submarginal, the present systems of local government have been organized upon the assumption that the land would be intensively developed as private property. The inability of private ownership and management to develop and continuously utilize this land in harmony with both the local welfare and the public interest has already taken from hundreds of local governments the very foundations upon which they were erected. Under such conditions public acquisition will be merely the taking over of lands of doubtful value as a source of revenue for local governments.

In many respects public acquisition will merely compress into a few years a process of fiscal readjustment which would otherwise extend over a longer period. In this process it is to be expected that the instruments for effecting economies in local government, now being advocated and experimented with will be effectively used, such as consolidation of counties towns, school and road districts, and the elimination of towns and school districts. These adjustments will be strongly conditioned by the State policy toward either assuming the burden of such services as roads and elementary schools or the extension of aids to local units to perform these services.

In addition, the present practice of the Federal and many State Governments of sharing with the local units a portion of the net return from the public lands should be extended to the lands acquired under this program. This sharing of income should be the basic principle upon which funds are apportioned, over a long term of years, to the local governments. It might be modified or supplemented in one of the two following ways, if circumstances warrant:

1. Where a preponderant part of land over large areas is acquired by public agencies, and in which there are a few dispersed inhabitants or small communities, it may be advisable for the State, with the possible assistance of the Federal Government, to administer directly such services as schools, welfare, and roads, and the enforcement of State laws. Local people should participate in the maintenance of such services to a reasonable degree. This would permit a very minimum of local government, much after the pattern of the unorganized territory of Maine.

2. Where public ownership is not so general as to justify direct State administration and jurisdiction, but is extensive enough to impose upon the local governments serious burdens for maintaining the peace of public lands within its jurisdiction and providing other public services, direct financial assistance might be granted the local units at least until the lands produce some revenue to be shared with them. The guiding principle should be to pay the local government an amount commensurate with the duties imposed on it by virtue of sharing the public land within its jurisdiction, but not necessarily enough to compensate for loss of tax revenue from the land. This latter would likely only subsidize an obsolete form of local government.

SECTION III

VIII. A PROGRAM FOR PERMANENTLY TAX-DELINQUENT AND TAX-REVERTED LAND[1]

As already noted, the problem of tax delinquency is one of the conditions that demands a new approach to the entire subject of land acquisition and public ownership of land.

The Present Situation

In the poor land areas, even prior to the depression, tax delinquency was creative of a virtual upheaval in private land ownership, and in recent years the condition has grown steadily more serious. Large areas have been thrown into the hands of taxing units, while a great deal more remains suspended between private and public ownership. With certain exceptions, the recipient units have not undertaken orderly handling and administration. On the contrary, fiscal expediency has most frequently appeared to suggest return of such lands to private ownership and the tax base as quickly as possible with the faint hope that such return will have at least a degree of permanency. In recent years that hope has been faint indeed. The result has been the creation of a vast, scattered, and disorganized area, much of it of uncertain legal and economic status. Thus "new public domain", as it has been called, is under the control of hundreds if not thousands of political jurisdictions, and shades by degrees from public into private ownership with a constant fluctuation between the two. It is virtually planless both as to present administration and conservation and future disposition. It presents a challenging demand for lines of action looking toward effective and permanent reform.

Forms and Degrees of Tax Delinquency

As popularly applied, the term "tax delinquent" refers to all land that has against it unpaid and overdue tax levies. Thus, it refers to land upon which the current due levies are unpaid for any one of a variety of reasons, and it refers to land which has a delinquency history extending over a considerable period of time. The latter includes land that is a year or more delinquent which has not gone through tax sale; land that has passed through tax sale but which may still be redeemed for a considerable period by the owner; and land where the thread of previous ownership is becoming decidedly weak as the period during which the right to assert ownership draws to a close. Popularly the term tax delinquent is also applied to land that has passed through tax sale at which no private buyer thought the land worth the amount of taxes and penalties due, with the State or county automatically becoming the holder of the tax lien or tax certificates. The final stage in the process is reversion to the State upon expiration of the period during which the land may be redeemed. In some States under the present law and practice the period during which land may be redeemed by the owner is highly indefinite, if, in fact, the right to redeem ever expires.

Short-term delinquency—that of a more or less temporary character—is a fiscal problem and a problem of the depression rather than one of faulty land use. Longer-term delinquency—that of a chronic character leading to reversion—is on the other hand rather definitely a problem of the poorer land areas where present use in agriculture or forestry has been of doubtful advantage to the owners and of doubtful service to the community. In the case of farm lands, tax delinquency leading to reversion has been a corollary of farm abandonment, frequently in areas where settlement has been of a scattered and costly character. It is in cut-over and forest areas, however, that delinquency leading to reversion has been most widespread. Cut-over lands, once held in anticipation of possible settlement, have been allowed to go delinquent as the possibility of sale for such purposes became more remote, and speculative values disappeared. Likewise, a none too favorable market outlook for the future lumber supplies has discouraged the holding of land for restocking and has even led to the abandonment of poorly located and inaccessible stands of raw timber. Tax delinquency, in many cases, has been used deliberately as an avenue of escape from a property right too burdensome to maintain.

The northern cut-over sections of Michigan, Minnesota, and Wisconsin probably present the most striking picture of permanent tax delinquency. In Michigan there are approximately 3 million acres of "State tax lands"—that is, lands that have been offered for sale for taxes and subsequently bid in by the State in the absence of private purchasers. In Wisconsin 2½ million acres in 17 northern counties were sold in the 1927 tax sale, and in that year the same counties were eligible to

[1] J. K. Galbraith and Kenneth H. Parsons, Land Policy Section, Agricultural Adjustment Administration, have contributed material which has been utilized in the preparation of this chapter.

take deed to 492,642 acres unredeemed after previous sales.[2] The Copeland Report suggests that present trends indicate a possible reversion to public ownership of 6,000,000 acres within the next decade.[3] In 16 northeastern Minnesota counties 6,830,840 acres of land were delinquent on January 1, 1931, on levies of 1929 or before. This amounted to 44 percent of the total taxable areas. Most significant is the fact that of the above acreage over 4,000,000 acres were delinquent on levies of 1926 and before, while 733,480 acres were added in 1927 and 944,560 acres in 1928.[4] Had legislation providing for the deeding of delinquent land to the State, passed in 1927, become effective in 1933 (as originally intended), it has been estimated that at least 4,000,000 acres would have been deeded in that year.[5]

In keeping with the less advanced stage of timber removal, the proportion of the total area delinquent in the Pacific Northwest does not appear to be yet as great as in the Lakes States although there is indication of a similar trend. There appears, however, to be strong indication that the Pacific Northwest is an area of potential large-scale reversion, following upon the removal of timber wealth. The area now in public ownership, or definitely headed in that direction, while apparently large may be but a forerunner of a still greater reversion in future years, if the experience of other forest States is borne out in this region.

The third important area of tax delinquency and reversion includes the States of Florida, Louisiana, Arkansas, and Mississippi. A recent study by the Southern Forest Experiment Station [6] gives the following estimates on tax reversion for these States, together with Texas and Oklahoma:

State	Total area reverted	Forest area reverted
Florida	11,800,000	7,670,000
Louisiana	2,708,000	1,354,000
Arkansas	1,880,000	1,260,000
Mississippi	1,250,000	750,000
Texas	920,000	690,000
Oklahoma	600,000	540,000
Total	19,238,000	12,272,000

While these figures, particularly those showing the proportion of forest land, are to be construed as estimates, they are sufficiently accurate to be indicative of the importance of the problem. In the case of Florida, a considerable share of the delinquency and reversion is to be related to a partial break-down in the collection of the property tax, the aftermath of real-estate speculation and tax increases during the twenties.

Public Policy with Respect to Chronically Delinquent and Reverted Land

Where land has little or no present or prospective return and hence has a negligible value, some public expenditure is entailed by its very existence. This cut-over forest land must be protected from fire, both as a protection to the community and to conserve the soil and a future timber crop in which the community has an interest. Where the land does have a small value, expenditures on roads, schools, and protection are often wholly necessary to the sustaining of such value. It is reasonable that this land should pay a certain minimum for these services. The present practice of assessing low-value lands at a certain minimum is recognition of this principle. If this minimum is not paid, then they revert to public ownership through delinquency. Broadly speaking, this procedure has much to justify it. If public expenditure is entailed on certain types of property without return, then the community should have the right to acquire and direct such use of the lands as best befits the public interest. Encouragement of continued private ownership through more or less complete elimination of taxes would involve an outright subsidy to such private ownership. In the case of inferior forest lands, were these exempted from all public responsibility in the form of taxation, there is no evidence that private enterprise would be, in general, willing to make the investments necessary to encourage or even to protect new forest growth. It has yet to be demonstrated, in fact, that any form of private enterprise can be induced to await a return on investment, even if comparatively promising, if such return is a lifetime or more remote. In the absence of any possibility of satisfactory employment of this land in private ownership there is no apparent alternative to a consolidation of the public ownership which now technically exists. The question, in fact, is whether the unsatisfactory type of public ownership which now obtains will be permitted to continue.

Recommended State Action

The following types of State action are recommended:

1. As a general rule it seems desirable that the State be the unit of Government to which land should revert for nonpayment of taxes. At the present time, land reverts to the State through tax delinquency in only 19 States. In 23 it reverts to the county, and in 6 to the town. But there are a number of reasons for believing that the State is a more practicable and effective unit

[2] B. H. Hibbard, John Swinehart, W. A Hartman, and B. W. Allin, "Tax Delinquency in Northern Wisconsin," Wisconsin Agricultural Experiment Station, *Bulletin 389* (Madison, 1928), p. 20

[3] *A National Plan for American Forestry.* S. Doc. 12, 73d Cong., 1st sess., p. 877.

[4] Roy G Blakey and associates, *Taxation in Minnesota* (University of Minnesota, Press, Minneapolis, November 1932), p. 120.

[5] Forest Tax Inquiry, unpublished material on file at the Forest Service, U. S. Department of Agriculture.

[6] Craig, R. B., "Reversion of Forest Land for Taxes Increases in the South," U. S. Department of Agriculture, Forest Service, Southern Forest Experiment Station, *Occasional Papers*, no. 32, p. 1.

than the county or town for the administration of lands acquired through delinquency and reversion. Many of the feasible uses of tax-reverted lands are highly extensive in character and as such cannot in general be effectively administered by a local unit. Such a matter as the orderly exchange and blocking up of reverted lands as undertaken by Michigan could not be as satisfactorily handled on other than a State-wide basis. Most important, however, is the fact that the county or town is itself an inextricable part of the complex of delinquency and reversion.

It would probably be impracticable to so modify the laws that tax delinquent land would revert to the State rather than the county in such a State as Wisconsin, where much progress has been made in organizing and administering land acquired by the counties through tax title.

2. A policy should be followed of taking tax deed after the expiration of a definite redemption period. In Michigan 5 years of delinquency has been considered presumptive evidence of the failure or renunciation of private ownership, and, on the whole, 5 years from the first delinquency should serve to establish the failure of private ownership except under conditions of inordinately high taxation or extreme economic stress. In the case of forest and cut-over land this period might well be shortened.

To avoid the delay in taking title which has commonly been manifest in handling tax-reverted land, it is believed desirable to require by statute that deed be taken within a given period after the land is eligible for tax title. Such a definite time period—which need not exceed 6 months from the expiration of the redemption period following sale of the land for taxes—would make the procedure with reference to reverging land definite and direct.[7]

3. Modification of stay laws or other relief measures to exclude application to chronically delinquent and reverted land. There is considerable justification, whatever its ultimate fiscal implication, for much of the legislation in recent years which has sought to aid the property owner who is in severe distress as the result of the drying up of his revenues through depression. The same legislation, however, has served to perpetuate the highly indefinite status of the land which in good times and bad had been unattractive to private ownership. Subject to local modification, it is hence believed highly desirable that steps be taken to except land with a long and more or less permanent delinquency record from the provisions of laws designed to help the taxpayer whose problem is one of emergency distress. Likewise, this is a provision that is to be strongly recommended for inclusion in such similar legislation as may in the future come before State legislatures.

4. The clarification and strengthening of title reverted and deeded to the State. One of the major difficulties hitherto in bringing order out of chaotic ownership conditions surrounding delinquent and reverted land has been the obscure legal status of delinquent land and insecure character of tax deeds in many of the States. Provision for the strengthening of tax deeds is a prerequisite to effective handling of reverted lands.

Application of a statute of limitations to the period during which the State's title may be contested appears to be the most simple and most satisfactory way for the State to free itself from the many existing difficulties with tax titles. At least two States, Michigan and New York, have taken action along this line.

The application of a statute of limitations is not proof against possible adverse interpretation by the courts, and there are undoubtedly ways in which the effects of such a statute would be nullified. It appears, however, to be by far the most hopeful avenue for bringing order out of the maze of technicalities surrounding tax titles.

5. Establishment or designation of an existing State agency to control tax-reverted land. The need is obvious for a board or State agency to administer or give direction to the handling of land which is acquired through tax title. However, the abandon with which a vast area of reverted land has been allowed to "drift" in recent years suggests the need for stressing the importance of providing land that reverts through tax delinquency with a competent administration. Usually the responsibility should be assigned to an agency already charged with the administration of land owned by the State. In those States where tax-delinquent land reverts to the county, cooperative effort between State and local officials may effectively direct the utilization and management of the land.

6. Powers and policies of agency charged with control of tax-reverted lands. A physical and economic inventory (including an adequate survey) of the reverted lands as they are acquired and their classification according to the best use is clearly essential as a tangible basis upon which further decisions respecting this land can be based. Ideally such an inventory and classification would be the first step following the adding of land to State holdings. Experience, particularly in Michigan, has shown, however, that the reverted land, except in the poorest areas, has shown a considerable scatter-

[7] It is necessary to recognize certain exceptions to this general statement of the desirability of taking title to all land delinquent for a definite period. In some States delinquency is due to faulty tax-collection procedure as well as to renunciation of title by the private owner. A specific case is Florida, where wholesale, although nominal, reversion to the State is the result of a more or less complete break-down in the collection machinery of the property tax and the construction of unwarranted improvements during the speculative land boom. It would appear desirable in Florida that the State accept the responsibility for lands with a long delinquency history, to which private title is not being asserted, and that it make provision for clarification of the State's deed to such land. At the same time recognition might well be given to the fact that other lands, technically reverted, but on which the private owners are willing to pay reasonable taxes and which they are sometimes occupying, have against them an impossible burden of taxes. The liquidation of this burden to the point of ability to pay would merely be a recognition on the part of the unit of government in question and its creditors of a situation which sooner or later must be faced.

ing. Under such circumstances classification of land as it is acquired is a costly procedure, and the best approach to classification of delinquent lands would be to make this procedure but a part of a larger program for inventorying and classifying all lands—or at least all lands in those areas where the best land use is problematical. It is desirable that the body charged with control of the reverted lands have complete authority to effect exchanges for the purpose of blocking up State holdings, on the basis of lands of equal value, and not necessarily of equal acreages.

Recommended Federal Action

Independent action by the Federal Government upon problems of delinquent and tax-reverted land is not likely to be successful. Tax delinquency and reversion grow out of the employment and administration of the property tax, which by tradition as well as constitutional right is a prerogative of State and local governments. These will probably remain matters over which States and localities feel that they have the most immediate jurisdiction. Moreover, before any semblance of order can be brought to the handling of the delinquency domain, State legislation is necessary to bring such land under central State control and to clarify the maze of technicalities and uncertainties which surround the legal status of such lands.

On the other hand, as other sections of this report have amply stressed, the land is a national resource in which all people of the Nation have a common interest regardless of political boundaries. Such being the case, the Nation cannot view with equanimity the disorder and waste of lands upon which private ownership has failed, and for which no constructive policy has been developed. The following recommendations for action by the Federal Government are in keeping with the national interest in tax-reverted lands while at the same time recognizing the tradition of State jurisdiction.

The Federal Government would assist the States in classifying the reverted lands as a part of the general cooperative scheme for classification and inventory of lands discussed elsewhere in this report.

It also would seem feasible to extend the present submarginal land purchase program to include the acquisition of nondelinquent tracts scattered through the area of reverted lands. This program should also include assistance to families in relocating which are on both these scattered holdings and on the land which reverts through tax delinquency. This procedure would convert such areas to public ownership entirely and offer strong support to a program of zoning by the purchase of land otherwise in a nonconforming use.

It may also be feasible to have the Federal Government grant assistance to the States in the development and management of the tax-reverted lands; such a grant should be a part of a general plan for handling other State-administered lands, including the areas acquired in the submarginal land purchase program which are under the administration of the State.

SECTION III

IX. REQUISITE PROCEDURE AND ORGANIZATION FOR THE DEVELOPMENT OF A UNIFIED LAND PROGRAM[1]

General Objectives and Practicable Scope of Government Land Planning

In approaching the problems of procedure and organization in land planning, it is important to recognize that in the past, Government, Federal and State, has participated in a variety of planning activities. Although there has never been a coordinated plan or plans embracing an integrated attack on the land problems of large areas, there are important experiences and precedents in method and organization which may be extremely valuable in the development of a unified land policy.

The broad objective of land planning should be the greatest good to the largest number in the long run, as distinguished from merely exclusive individual profit or advantage. In the past the application of this principle has been made to a few specific resources, such as minerals, timber, etc., in limited areas. The new objective requires its application to areas and regions in terms of all forms of land use and the adequate integration of the various uses in an area. Public land planning is not merely a consideration of what use a particular type of land is adapted to as viewed from the standpoint of the profit criteria of private economics. It is rather a discriminating application of public policies to the types of land and associated economic and social situations to which such policies were designed to apply.

It is probably not practicable at present to apply this approach to all areas and regions, or to work out quickly and surely all the details of a complete and permanent land use plan for the entire country. In fact, policy, organization, and procedure in planning always must be elastic and adjustable, and should not be conceived as ever crystallizing into a fixed and permanent mold. The ideal is to be approached through focusing planning activity on areas of obvious maladjustments in land use and resulting economic and social distress. Through experimental handling of such areas, practicable methods and means may be worked out for the solution of land problems, broadening gradually into general planning policy and procedure. Thus the long-time policy and planning organization and objectives will develop naturally out of the current experiences. A major need follows in the closest checking and inspection of methods, procedures, results, and experiences derived from the attack on problem areas.

The development of planning and policy through such an approach requires redefinition, diversification, and clarification of the concept of problem areas. Problems of land use attach to all areas, good and bad, with constant shifting and changing of relationships between the physical, economic, social, and political factors involved. However, there are certain areas where the problems of maladjustment in land use and tenure are peculiarly acute and of a character to require governmental action for their solution.

General Character of Procedure

In theory it would be desirable to have at hand a complete physical inventory and adequate and dependable data of various types, physical, economic, and social, on the basis of which to assess the problem status of all areas, to determine the relative urgency of public action, and to work out the means of readjustment and development. Practically, it is impossible to achieve such a theoretical basis for operations. Not only do the limitations of time, money, and personnel make a complete inventory impossible, but there remains the fact that only through the actual operation of integrated study of specific areas from all angles can the essential requirements for base data be determined, and the requisite techniques and technicians developed. It is necessary and possible, however, to locate enough areas of obviously urgent need for readjustment and constructive land use development to serve the purposes of any immediately feasible planning program. Preliminary work toward this end already has been done. The surveys made for the present report have served to provide maps showing the approximate location of areas characterized by various types of maladjustments in land use. These maps comprise, therefore, a first approximation, which will serve as a working basis for further refinement through more intensive work if and when it becomes desirable to apply certain policies to these various areas. Designations of problem areas have been made on the basis of data already at hand or readily obtainable. It is recognized that such pro-

[1] The following persons have contributed material which has been utilized in the preparation of this chapter: Kenneth McMurry (collaborator) and J. K. Galbraith, Land Policy Section, Agricultural Adjustment Administration; W G. Mendenhall, Geological Survey; Robert H Connery, National Resources Board; J. B. Kincer, Weather Bureau; Isaiah Bowman, Science Advisory Board; and W. L. G. Joerg, American Geographic Society.

cedure inevitably is imperfect, and some of the results obtained of doubtful accuracy. Gradually more intensive field work will permit the refinement of the various areal designations.

In the actual procedure of planning and the adjustment and development of specific areas, experience has demonstrated some of the essential steps. As applied to any specific problem area, provision should be made for: (1) Adequate inventory of physical, social, and economic phenomena and their areal and functional correlations and interrelationships; (2) compilation and analysis of such data, and the derivation of working plans from them; and (3) administrative machinery and procedure for putting the plans into effect. An immediate problem is to assess the agencies and personnel available for these objectives, to supplement them with such other resources as may be necessary, and to work out a scheme for organization to integrate, focus, and activate the whole toward the end of effective action. This process should be based fundamentally on the use and adaptation, as far as possible, of existing agencies and personnel.

There are a number of Federal and State agencies with large experience in various aspects of land administration, investigation, and planning. These agencies, however, have in general pursued specialized objectives rather than a broad and diversified program of land planning aimed at correcting pathological conditions of land use in particular areas.

Federal Organization for National Land Administration and Planning

It has long been recognized that the Federal Government is at present poorly organized in respect to land administration and the formulation of adequate plans for land use. At least nine distinct bureaus or agencies in several departments are engaged in major responsibilities for land administration, while a much larger number are carrying on investigational, mapping, and service functions that contribute to land planning and land administration. There is wide variation in objectives and procedure as between individual agencies.

In general, the problem of integration has several main phases which require discussion. An obviously important phase is that of administration of areas owned by the Federal Government. Four bureaus in two departments have at present a major responsibility of this character. The problem is how to obtain proper coordination of such functions as forest management, protection, game management, and recreational administration in such areas. It is recommended that the major break-down of responsibility between administrative agencies be areal rather than functional. In the development and carrying out of plans for specific areas there should be centralized responsibility for all the various functional aspects of land administration, which should rest with the agency responsible for the major form of land use in the area. The administrative agency may be predominantly an agricultural, range management, forestry, Indian, or recreation agency, depending upon the major use of land in the given administrative units; but planning for other land uses than these special lines should be part of the function of each such agency, in order to most effectively coordinate land-use activities within each areal jurisdiction. Each of the agencies will have technicians versed in the specialities of the other agencies on their staffs, and should undertake to aline its major policies with those of the other Federal administrative agencies insofar as consistent with the character of the area and the major purpose for which it is reserved, acquired, or retained in Federal ownership.

Technical investigational work relative to the major use of the land in such administrative units should in general be carried out under the direction of the administrative agency in charge with such collaboration from governmental agencies as may be expedient. In general, such collaboration should be sought from established investigational agencies which have special competence for the particular phases of research needed, whenever this is consistent with unified administration in dealing with problems of the area. The administrative agency in charge should also assume general responsibility for investigational work necessary for determining the policies and their application to the specific conditions of the area for which it is responsible.

In the acquisition of land the problem of coordination is more serious. At present a large number of Federal agencies are engaged in land acquisition in accordance with their various specialized objectives. There is serious need for integrating these various undertakings, not only among themselves but also with the land acquisition programs of the States, in order that the pattern of public ownership may be symmetrical and the specific areas of land be put to the form of use and the type of ownership most consistent with the general welfare. As indicated in previous recommendations of this report, there are certain areas now under the administration of specific bureaus which should be transferred to the administration of other bureaus.

It is believed that these phases of integration will require the intervention of a Federal agency outside of existing departments and reporting direct to the President. This agency should be provided with requisite personnel and funds to enable it to provide the desired coordination of our public land acquisition programs, including effecting transfers of land from one Federal bureau to another. It should be a function of the proposed Federal agency to determine the use that should be made of lands viewed from the standpoint of general welfare, including determination of what areas

should be in public ownership, whether they should be in Federal or in State ownership, and what Federal agencies are in the best position to administer the land. Initial attention should be given to areas where there are serious problems of economic dislocation, such as tax delinquency, extensive areas of "idle" land for which no constructive policy of use exists, submarginal farm lands, and special areas proposed for acquisition by Federal or State agencies. This Federal land coordinating agency should encourage and aid in financing the development of corresponding agencies in each State, which should work with all existing State land-administering agencies with a view to integrating their policies and programs. Such a Federal coordinating agency would emphasize the principle of a real responsibility for land administration, deal with the problem of avoiding scattered ownerships and resulting overlapping responsibility, and undertake to promote consolidation of existing ownership patterns.

The proposed Federal agency should not be charged with the administration of publicly owned areas nor should it build up an extensive investigational staff beyond what is needed to supply necessary leadership incident to its primary task of land planning and coordination of land acquisition. In the main, it should rely on the fact-finding facilities and the land-acquisition machinery of the existing Federal and State agencies.

The need for a national agency capable of attacking the problems of idle land and coordinating the activities of various Federal and State agencies for this purpose is particularly urgent in dealing with the problems of tax-delinquent land. None of the existing Federal agencies is undertaking to deal with these problems in any comprehensive fashion, and few States have grappled with these problems effectively. These problems have to be approached from the broad standpoint of determining what areas should be returned to private ownership and what areas should be retained in public ownership, the type of use or uses to which the land is best adapted, whether it should be administered by the Federal Government or by the State, and what administrative agencies should assume the responsibility. It was recommended above that the Federal Government lend active encouragement to the early determination of these questions, collaborating with the States and sharing the necessary costs of investigation. It is further recommended that financial aid and cooperation for this and other purposes hereafter mentioned be contingent upon State legislation which makes definite provision for assumption of title to reverted land and for the clarification of such title as proposed earlier in this report. Federal participation would serve to unify and standardize the classifications in different States and aid in the coordination of State land policies relative to reverted land with other State and Federal land policies, relative to the problem areas within which reversion occurs, especially policies relative to public ownership.

The national interest in the protection of the tax-delinquency domain might justify also provision of Federal aid to States undertaking the orderly restoration and conservation of reverted lands. Such assistance, it is believed, should be contingent upon the existence or development of a satisfactory form of administration as discussed under Recommended State Action in the section above dealing with tax delinquency. Because of the variation in character of reverted lands and consequent variation in costs of administration and development of use, it is believed that aid should follow the traditional plan of matching State funds expended for these purposes. Proposal of Federal aid to administration and use of reverted land raises the question of justifiable expenditure on land of this character as well as questions of policy in State aids in general. Likewise, it raises the question of distribution of ultimate revenue from reverted lands as between the States and the National Government. Another possible line of division of responsibility would be for the Federal Government to arrange on some equitable basis to acquire from the State such reverted lands as appear to lend themselves better to Federal than to State administration.

It is recommended that the Federal Government take positive action in assisting the States in the consolidation of their holdings. The most desirable line of Federal assistance would appear to be the setting up of a project in each State taking suitable action relative to its reverted land. This should be closely coordinated with the program for submarginal land purchase, as well as with other Federal land acquisition programs. The Federal Government, through the submarginal land program or through other Federal land acquisition programs, should undertake the purchase of isolated private holdings—particularly of occupied holdings interspersed with tax-reverted lands—for purposes of blocking up the areas in public ownership. Such lands could be given to the States to be held in trust for the Federal Government or, subject to certain specifications of use and disposal, might be deeded to the State or exchanged for State lands needed elsewhere to block up Federally owned areas.

The Federal Government should also relieve the States of the problem of the isolated settler on reverted land or in areas of extensive reversion for which a general program of public ownership is desirable by taking responsibility for resettlement in more favorable locations. (See discussion of land settlement, p. 200.)

A final step by the Federal Government in assisting the orderly administration and use of tax-reverted lands is the extending of the aid and cooperation of Federal agencies to those States launching a satisfactory program, particularly in protection against fire, insects, and diseases, and in restoration of forest cover.

All of these problems of integration among Federal land agencies and between the Federal Government and the States appear to emphasize the need, already mentioned, for a new Federal agency to assume leadership in land planning and in the unification of Federal and State programs of land acquisition and administration.

Its primary function should be that of promoting integration, unification, and collaboration in land policy and administration, and it should be given adequate powers for the exercise of that function.

Organization for State Planning and Its Relation to Federal Planning

Land use policy must be locally applied, for it is essentially of local as well as general concern. The States, therefore, should participate to the fullest extent.

In both the Federal Government and in the States there are different agencies dealing with various phases of land use and policy. In most, if not all, States the coordination of their activities and integration of their policies is sorely needed. The formation of the State planning boards and commissions constitutes a recognition of this need, and some of these newly created agencies have made considerable progress in land planning. They require, however, considerable reorganization in composition and development, and perhaps major reorientation, before they may be expected to operate with reasonable efficiency.

In most of the States there are institutions and agencies which seem readily adaptable to effective planning organization. State departments, bureaus, or commissions dealing with forests, parks, fish and game, health, roads, schools, relief, taxation, land administration, and the offices of State engineer and State geologist are among those that have been named as members of State planning commissions or boards. The agricultural colleges, with their long experience in attack on certain land problems, with their trained personnel, and closely cooperative arrangements with the Federal Department of Agriculture, should be adequately represented in the State planning machinery. In some States representatives of certain departments in the State university should be associated with the State planning organization. Certain lay leaders may also have much to contribute.

In view of the obvious interest of the Federal Government in having a responsible land-planning agency in each State with which it may deal and cooperate, it has been suggested that the Federal Government continue to provide financial assistance to such agencies as in the case of the present State planning boards. There is danger, however, that this would lessen the independence of such an agency and its influence with its constituency. The greater part of the membership may be ex officio and therefore constitute little additional expense. There should be a full-time executive officer and a small secretariat.

However, the Federal Government may stimulate the setting up of such an agency by making the application of certain Federal policies and the granting of certain funds incident to those policies conditional on the existence in the State of a responsible land-planning agency with which the Federal Government may cooperate. This might include funds for public land acquisition under the submarginal land program, and the national forest, park, and wildlife programs, funds for crop adjustment and erosion control, and the funds for classification of tax-reverted land and other lands in problem areas, and for the acquisition of areas associated with lands that have reverted through tax delinquency.

Such State planning agencies should have functions corresponding closely with those suggested above for the proposed Federal land-planning agency. A very large part of the land inventory, analytical, and planning work necessary for an effective land program may be expected to materialize in and through such State organizations, if opportunities for undertaking the work are made possible through Federal cooperation. They should have either absolute or recommendatory authority to work out with the Federal Government the division of function with respect to public land ownership, the transfer or acceptance of responsibility for land administration from the State to the Federal Government or vice versa, cooperation with the Federal Government in developing a program for tax delinquent and other idle land, and coordination of the activities of various State agencies having to do with land investigation and administration.

This fundamental policy of development of planning through utilization, integration, and further growth of State institutions and agencies, with technical and financial assistance and encouragement from the Federal Government, has a very direct bearing on the various ideas of regional organization which have been advanced and locally put into practice. There are, of course, advantages from the Federal point of view in the setting up of regional administrative offices representing such Federal agencies, for instance, as the Forest Service, National Park Service, Biological Survey, and Land Policy Section of the Agricultural Adjustment Administration. Naturally, since each of these administrative agencies deals with very specific activities, the regional patterns do not coincide. In virtually all cases, it should be noted, these comprise groups of States and not physiographic regions. The obvious value and necessity of utilizing all available State agencies as the major base for planning activities causes conflicts with proposed regional planning set-ups based upon the concept of natural geographic regions, drainage basins, physiographic regions, etc. The State boundaries, with little or no relationship to geographic, hydrographic, or physiographic facts, must be cut across in the applica-

tion of such regional concepts. Whatever may be gained in such theoretical adjustment to physical factors is much more than offset by the fragmentation of State organization, and the economic, social, and political factors based on the long-established functioning of the State units. While a strict Federal imposition of planning might conceivably succeed best on such a basis, it would seem to be mistaken policy to proceed in such a way as to lose the high potentialities of State cooperation. This is not intended to imply, however, that the watershed is not the proper unit for hydrographic planning. On the contrary, the opposite conclusion is reflected in the present report.

The major points in organization and procedure for the development of a unified land program are summarized as follows:

1. Building up of a comprehensive policy and organization through a "problem area" approach, involving all land problems and phases of land use rather than attacking through some individual problem, and pointed toward both readjustment of present use and constructive development of new forms of use. The experience and knowledge derived from actual inventory, planning, and administration of such problem areas will provide the basis for future permanent organization and procedure.

2. Federal organization should be built up on the base of present agencies, with such adjustments, integrations, and establishment of new functions as may prove necessary with experience derived from actual planning. Immediate attention should be given to the means for the expansion of economic and social inventory and analysis, and to the use of aerial photography as a method of inventory, applied to the areas brought under planning procedure.

3. Integration and development of Federal planning to be brought about through interdepartmental cooperation focused on areal problems.

4. Dependence on State agencies, facilities, and personnel for the major share of work of inventory, analysis, and planning, and the training of men. This might be accomplished through setting up of a State organization involving and representing all agencies interested in land problems, with ample financial and technical assistance from Federal sources.

5. Regional organization on the basis of convenient combinations of State units, focused on all phases of land planning and use, with the prime objectives of encouragement of State participation, development, and use of local agencies.

Basic Physical Data Needed for Land Planning [2]

An acute need in planning land use is the completion of the topographic map of the United States. Only 46 percent of the continental United States is covered by topographic maps at present and only about 25 percent, according to the estimate of the responsible mapping agency, is adequately mapped for present general needs.

The attainment of this mapping objective may be greatly accelerated by the use of aerial photography, whose value for this purpose has been thoroughly demonstrated during the past decade and is constantly increasing with the improvement of equipment and methods. Through this medium planimetric maps, that is, maps without contours, may be prepared more rapidly than by ground methods alone, and for special purposes may be enlarged without a material sacrifice of accuracy. As base maps for land use planning, planimetric maps should be prepared as advance sheets and made available as rapidly as possible on a scale of 1:20,000 or 1:24,000, particularly of agricultural lands in the Eastern and Southern States where boundaries of farms and fields are not controlled by the rectangular system of United States land surveys and therefore are often highly irregular.

Planimetric maps, when prepared according to standard practices, serve as bases for the much more widely useful topographic maps with contours, and when more time is available topography in the form of contours may be added to them. The final publication scales of the completed maps may well be the standard scales now in use, namely, 2 inches (1:31,680), about 1 inch (1:62,500), and about one-half inch (1:125,000) to the mile. Choice of scales within the accepted limits at present depends and should continue to depend upon the nature of the problems within the area. Obviously, larger scales with their higher costs may be justified in metropolitan or other densely settled areas where problems are acute, whereas they may be wholly unjustified in thinly settled deserts of little economic value.

In addition to the maps, it will be very desirable in many areas to have controlled mosaics made from ratioed prints of the aerial photographs assembled in quadrangle units on relatively large scales. The aerial photographs should be procured on the 1:20,000 scale and the mosaics prepared on that scale or on the 1:24,000 scale for use by the Government units concerned in field mapping and classification of land use features, including crops, pasture, forest and other cover types, soils, eroded areas, and such cultural features as farm boundary lines, roads, and dwellings. Moreover, the acreage of each farm or field can be scaled from mosaics prepared in this way or can be measured with a planimeter. Such mosaics can be prepared as a byproduct in the general conduct of an expanded mapping program.

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[2] These suggestions do not attempt to cover all subjects that might come into consideration but rather to emphasize the most urgent problems calling for solution. Even in this selectivity they do not pretend to be exhaustive. In the main, these suggestions are based on the Science Advisory Board's report on "Land resources and land use in relation to public policy." Priorities of importance indicated in replies received in response to a questionnaire sent by the National Resources Board to the relevant Federal bureaus as to the problems in the field of each bureau most in need of solution have been taken into account.

Program for Immediate Future and Appropriate Agencies to Put It Into Effect

Topographic Mapping: The preceding remarks relate on the whole to long-range planning, although the suggestions regarding planimetric maps are directed to the early future. The present emergency, however, calls for differentiation between the immediate and ultimate needs. There follow, therefore, suggestions as to a program of topographic mapping for the next 3 to 5 years. In this connection the index map of the United States facing page 76 should be closely consulted.

Bearing in mind these available maps, it is suggested that the following areas be mapped first within the next 3 to 5 years:

1. The Great Plains: In Kansas a large area is available in quadrangles on the 1:125,000 scale, but, as the map (page 76) shows, most of this material is superannuated. In western Oklahoma and Texas some maps by the Corps of Engineers are available.

2. The Middle South, or mainly the Piedmont and the Coastal Plain from Virginia to Mississippi: In this area the Piedmont is characterized as being in the most advanced stage of soil wastage on the map showing general distribution of erosion, published by the Soil Erosion Service. In this area portions of the Piedmont are available in 1:125,000 standard topographic sheets, most of which, however, are antiquated. Of much of the Coastal Plain from North Carolina to Mississippi no maps are at present available.

Climatology and Climatic Risks: The most important desideratum under the head of climate is the study of climatic risks. Such a study would provide part of the necessary factual basis for control-planning in the case of such zones of hazard in agriculture and grazing as the Great Plains and the intermountain West. In addition to the investigation of the expansion and contraction of climatic areas it is desirable to determine the degree of hazard for specific crops or pasturage.[3]

The desirability of utilizing the new research method of air mass studies in the analysis of climate and in weather forecasting is not gone into here because

[3] The concepts and the methods of research involved in these 2 types of research will be set forth in the complete report on land utilization and policy.

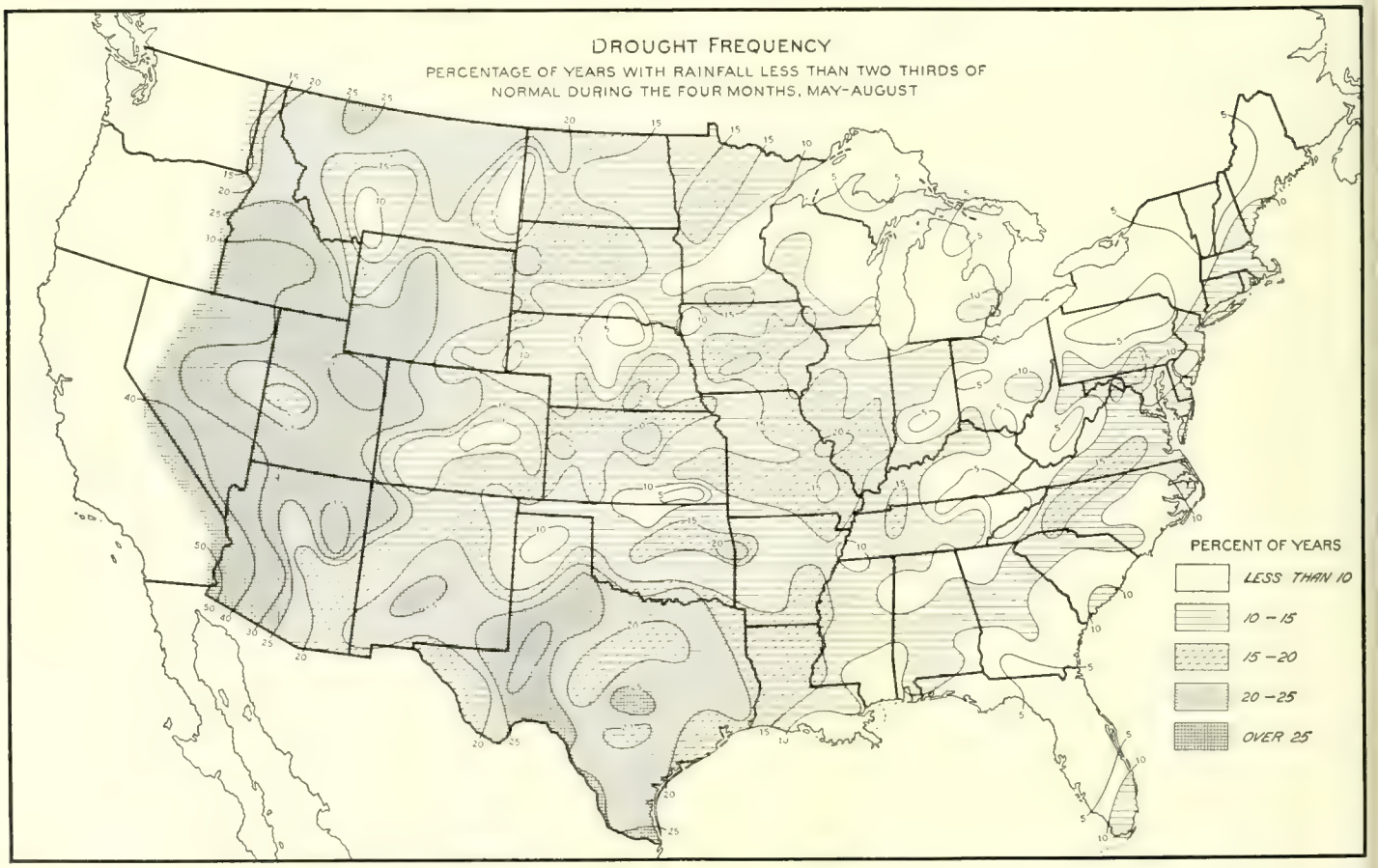
DROUGHT FREQUENCY
PERCENTAGE OF YEARS WITH RAINFALL LESS THAN TWO THIRDS OF NORMAL DURING THE FOUR MONTHS, MAY-AUGUST
PERCENT OF YEARS
LESS THAN 10
10 – 15
15 – 20
20 – 25
OVER 25

FIGURE 67.—This map, prepared by the Weather Bureau in cooperation with the National Resources Board, shows the frequency of rainfall shortage during the important growing months, May to August, inclusive. It indicates that droughts are relatively infrequent east of the Mississippi River, and as a rule, become increasingly frequent westward from the Mississippi Valley. In the Great Plains and intermountain regions droughts are especially serious because of the generally light rainfall and lack of moisture reserves. Further research to delimit more closely the areas of high climatic risk is necessary to a sound program of land use planning.

that has been detailed in the "Preliminary Report of the Special Committee on the Weather Bureau of the Science Advisory Board" (Washington, D. C., Nov. 13, 1933, pp. 9–12). It has also been referred to in the Science Advisory Board's contribution (dated Oct. 23, 1934; on pp. 9–10) to the Land Utilization Report.

An undertaking that would refine our knowledge of the climate of the United States is a phenologic survey of the whole country. Phenology is the term used to designate the period at which certain critical plants or trees begin to put forth their leaves, which period hence indicates the beginning of spring. Such a survey, undertaken for a large area, indicates especially well in temperate latitudes the poleward advance of the renascence of vegetation growth within a given year. The isochronic lines of this advance often reveal climatic differentiations more intimately than any other records. Coupled with such data indicative of the onset of winter as dates of first killing frost, the data of phenology may also define the growing season.

Carrying out a phenologic survey of the United States involves no special difficulty. Some records are already available (see Science Advisory Board's report on Land Resources and Land Use in Relation to Public Policy, bibliography, pp. 180–181) and, where not available, the survey could possibly be carried out by enlisting the the services of school children throughout the country, as was done with signal success for similar work in Nova Scotia some 20 or more years ago. The services of the cooperative observers of the Weather Bureau, the Crop Reporting Service of the Department of Agriculture, and the Forest Service might also be enlisted.

Soil and Surface Conditions: An important research problem requiring investigation in soil science, is the study of soils from the standpoint of geomorphology, i. e., in their relation to slope and surface. The method advocated has been applied experimentally under the Soil Erosion Service in the summer of 1934 to the area of the Navajo Indian Reserve.[4] The Soil Survey has also recently been indicating relationships between soil and slope and surface.

Soil Fertility Survey: About one-half of the agricultural area of the country has been covered by soil surveys. (See fig. 68.) Gradually methods have been modified as new conceptions of soil classification have developed and new needs for the data become apparent. During the lifetime of the present soil survey in the United States the underlying philosophy has progressed from what may be termed the "geological" viewpoint to a basic concept that may be termed "climatological." The Survey now describes and appraises soils according to their important characteristic influencing productivity, including structure, depth and stoniness, texture, chemical composition, water-holding capacity, slope, and character of surface. As a result of recommendations by the National Land Use Planning Committee, the Survey undertook a classification and inventory of land types according to inherent physical productivity. This is in progress. These surveys are especially helpful for land use planning and, with such modifications and adaptations as may be found requisite to show relations to slope and surface conditions, should be rapidly extended.

Vegetation: In addition to the study of grasslands advocated as a prerequisite to the formulation of measures to combat the deterioration of the range lands,[5] the following undertakings commend themselves in the field of planning:

It is desirable to establish natural, primitive, or wilderness reserves in every vegetation region of the United States. As previously noted, these are provided for in some regions by the wilderness areas of the National Park Service, the natural areas, and primitive areas set aside by the United States Forest Service.

These reserves, however, are principally in the West. Elsewhere the situation is hit-or-miss. Individual States, on the initiative of local groups, have here and there acquired a virgin tract as a public monument. Thus Iowa and Illinois have set aside small bodies of prairie sod as mementos of pioneer days; Michigan has rescued some virgin white pine lands by which to remember its great lumber period, and California through its Save-the-Redwoods League has flanked the Redwood Highway at intervals with State parks consisting of virgin redwood groves. Ecologically, however, such State parks are not satisfactory as compared with the national wilderness reserves because they are freely accessible for recreation and are in many cases picnic grounds of great popularity.

For some natural areas we are virtually at the last moment if a tract is to be preserved in its virgin condition. In all areas the choice of available sites is narrowing steadily. Such protected tracts are for any natural vegetation unit basic to the study of the alteration of vegetation, soil, and slope. The scientific importance of such areas in themselves and for applied studies is undisputed; the time element is urgent, even critical. Perhaps no existing public agency can propose a program of saving a primitive locality in every natural region of the United States. Such a program, however, commands the interest of a half dozen Government bureaus and likewise that of a large number of natural scientists throughout the country. This is a question in which such a body as the National Research Council might well take the initiative by appointing a broad committee on natural reserves which would gather evidence as to where in each natural area undisturbed tracts are, whether they are scientifically suitable, and whether they would be suitable for limited recreational

[4] Detailed discussion of methods will be included in the full report on land utilization and policy.

[5] This will be discussed in detail in the complete report on land utilization and policy.

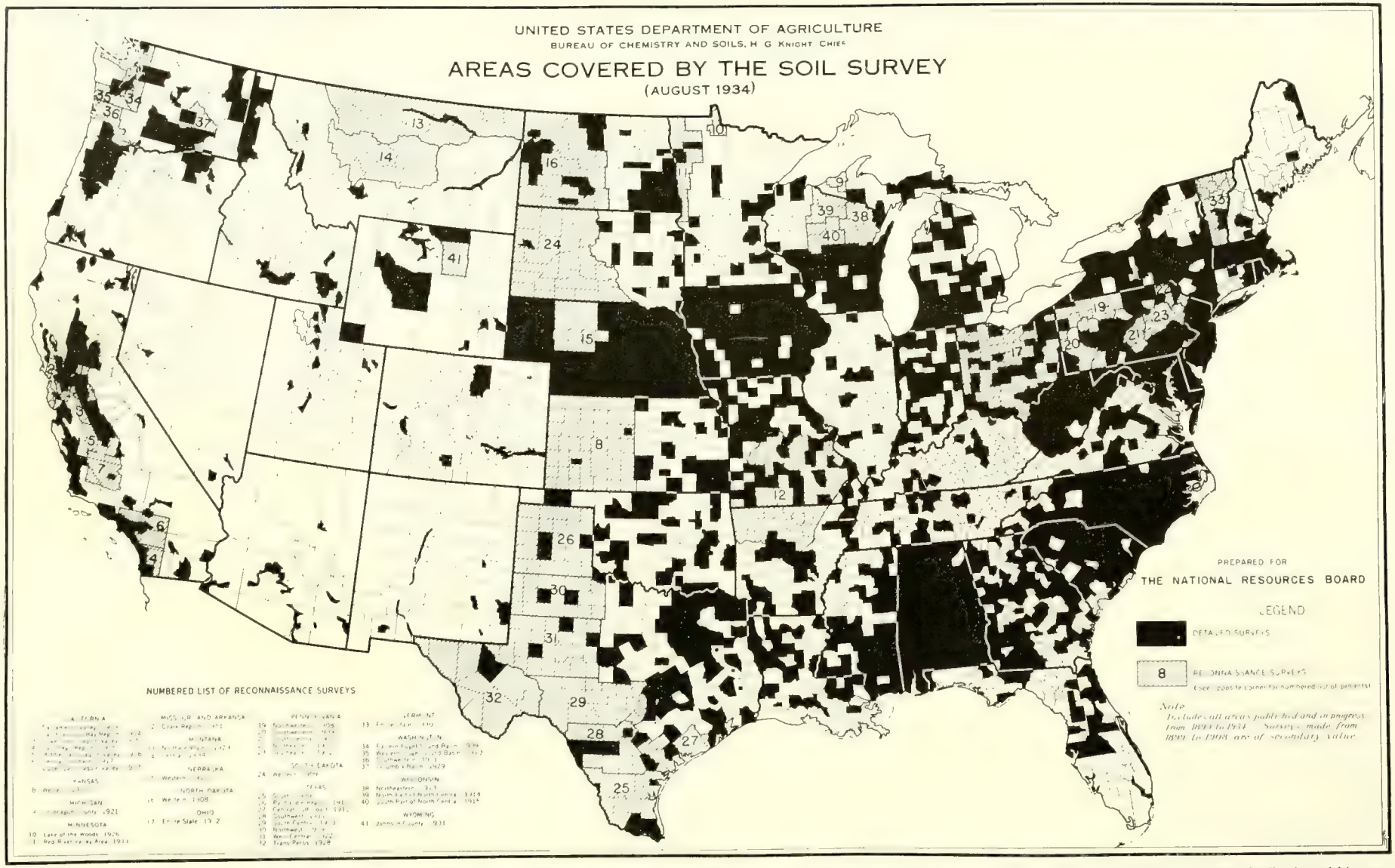
UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF CHEMISTRY AND SOILS, H. G. KNIGHT, CHIEF
AREAS COVERED BY THE SOIL SURVEY
(AUGUST 1934)
PREPARED FOR
THE NATIONAL RESOURCES BOARD
LEGEND
DETAILED SURVEYS
8
RECONNAISSANCE SURVEYS
(See table for complete numbered list of projects)
Note
Includes all areas published and in progress from 1899 to 1934. Surveys made from 1899 to 1908 are of secondary value.
NUMBERED LIST OF RECONNAISSANCE SURVEYS

FIGURE 68. In detailed soil surveys, the surveyor undertakes to examine an area carefully enough and with sufficient accuracy to enable him to determine the character of the soils and map their distribution within every 10-acre tract. The determinations are made by the field men on the ground. A soil survey, therefore, is a survey in which facts are determined by specialists working on the ground and not by the collection of information from residents. A reconnaissance survey undertakes to determine and locate the areas of the more important soils without undertaking to determine minor details of character or areas smaller than about 40 acres. Such surveys have their greatest value in regions such as the Great Plains, where soils of uniform characteristics occur over large areas. They are of much less value in regions like those of the eastern parts of the United States, where soils differ widely within very small areas. When soil survey work was begun in 1899, no methods for doing such work as was demanded had been worked out in the United States or in any other country. Systematic and accurate knowledge of soil characteristics in the United States was practically lacking, making it impossible to create or define soil units. Until methods for doing this work had been worked out and considerable progress made in actual studying, according to these methods, the soils of the United States, maps of primary value could not possibly be constructed. These methods had been worked out with sufficient accuracy by 1908, so that from that time on soil survey maps have been relatively accurate and of good quality. Mapping done previous to that date must be defined as of secondary value, but the maps contain data, which, by interpretation in the light of later studies, have very great value.

use, and to consider means of getting such areas into public ownership or otherwise permanently protected.

Setting Aside Destructively Exploited Tracts for a Study of Their Natural Regeneration: The Forest Service has many experimental and observational plots thus set aside and is securing their records. Elsewhere State foresters and schools of forestry are proceeding similarly. Withal, there are large sections of the country where such experimental areas are lacking. Here, in contrast to the primitive tracts, there is almost unlimited choice of land, and cost of acquisition is negligible. Tax-abandoned lands and submarginal lands now being acquired will provide an abundant choice for virtually every type of destruction in every region. Such reserves would serve admirably in addition as wildlife sanctuaries.

Studies in Degenerative Vegetational Succession Under Continued Abuse of Surface: Existing soil erosion experiment stations afford a particularly favorable place for the ecologist to study the effects of continued deterioration on plant societies, to record the species that serve most significantly as indicators of stage of deterioration, and thereby to determine the most valuable elements of the native flora in arresting erosion at a given stage.

Study of the Genetics of the Domesticated Plants Native to America with Regard to Their Directed Breeding: An important project under the head of vegetation is the study of the genetics of the domesticated plants native to America with regard to their directed breeding. This is related to and would be, in a sense, a continuation of the work long done by the Bureau of Plant Industry to find types of cereals which would resist unusual weather conditions, such as drought-resisting wheats, etc. It would be of the highest order of scientific, historical, and economic interest to collect and grow the primitive strains and varieties of the plants domesticated by the American Indians, beginning with the trio of maise, beans, and squash, and including cotton, tobacco, Irish potato, sweetpotato, manioc, peanut, tomato, and others, to determine their chromosome groupings and to provide a base for plant-breeding experimentation for traits desired in American crop systems for various soils and climates. This is one of the really great unrealized projects in American science, involving the whole of plant genetics, the economy of our crop regions, and the culture history and geography of aboriginal America. The activities of the Bureau of Plant Industry in collecting, breeding, and disseminating plants, as well as in the field of plant genetics and plant breeding, might well be expanded.

Mapping Population Distribution: As planning involves setting up conditions which affect the distribution of population, and even shifting population bodily, it is of paramount importance to know the present population distribution of the United States. The only adequate means to visualize this is on maps, and at present there are no adequate maps to serve this purpose. Those produced by the Census Bureau are either on too small a scale or too diagrammatic to give a really intimate picture, and the few maps prepared in private research relate only to scattered areas.

Proceeding from the premise that the distribution of population is not a phenomenon of uninterrupted, continuous gradation and hence is not properly portrayed by a system involving isopleths, it is here proposed that population distribution in the United States be mapped according to a system utilized on a number of foreign maps, notably the so-called "dasymetric" (density measuring) maps of European Russia and the population map of Great Britain recently published by the Ordinance Survey.

The present method constitutes a far closer approximation to actual conditions than the isopleth and cartogram methods. Its validity is evidenced by the fact that it lends itself equally to portrayal on a large scale, such as that of the 1:420,000 maps of European Russia, which are almost on so large a scale as to be akin to topographic maps, and on a small scale such as that of the 1:1,000,000 map of Great Britain, which places it in the category of general maps.

Densities by minor civil divisions can be calculated from the Census reports and plotted on the new series of State maps showing minor civil divisions recently gotten out by that Bureau. In so doing, urban areas should be segregated according to the limits by which they are defined in the Census reports and on the Census maps. These maps should then be scrutinized by persons familiar with the geography of a given region, urban areas segregated, and densities of the remaining rural population generalized and grouped into characteristic areas as in the aforesaid maps of Russia and Great Britain. The thus generalized densities might then be transferred to a set of the 1:800,000 State maps by the United States Geological Survey. This would provide a series on a uniform scale.

PART III
REPORT OF THE WATER PLANNING COMMITTEE

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LETTER OF TRANSMITTAL

November 15, 1934.

Hon. Harold L. Ickes,
Chairman The National Resources Board,
Washington, D. C.

Dear Sir: The Water Planning Committee submits herewith its report on principles and policies in the use and control of water resources, together with a brief summary of an inventory of those resources made under its direction and a group of papers prepared for it that deal with special aspects of water problems.

The Committee wishes to express its cordial appreciation of the unfailing courtesy and helpfulness of the Board, by which an arduous task was lightened materially. It trusts that the results of its labors may prove to be of substantial service.

Very truly yours,
The Water Planning Committee,
By Morris L. Cooke, *Chairman.*

WATER . . . . *A prologue*

The use and control of water resources presents a bewildering array of problems, some technological, some economic, some social, in which, without a guiding principle, it is easy to lose one's way. The vastness of our country, the wide range of climate and topography, the abrupt seasonal changes affecting most of our watersheds, all tend to make the formulation of a national water policy difficult. At the same time they also make it essential. Nothing short of a national policy can deal effectively, justly, and democratically with the situation.

Diverse though the needs and interests are of the different sections, and of different groups in the same sections, they are linked together by a common need and interest. The whole Nation is concerned in seeing to it that water shall provide the largest possible amount of beneficial use and do the least possible amount of damage.

There is no stream, no rivulet, not even one of those tiny rills which cause "finger erosion" in the wheat fields of the Corn Belt, that is not a matter of some concern to all the people of the United States. The individual and local interest builds up, almost imperceptibly, into the general and national. The individual and the locality profit most, in the slow movement of the years, if this larger interest is protected. If one of the deepest of human emotions, the love of parents for their children, is given full play, the whole generation of the living must find satisfaction in making sure that the wealth of the running waters is preserved and enhanced for those who are to come after.

Water rights have been differently interpreted in different places and at different times. The relatively damp climate of England gave birth to the doctrine of riparian rights; that is, that the landowners upstream should not take water in such a way as to interfere with their downstream neighbors' uses of the stream. The humid States of eastern America have tended to follow this precedent. The dry climates of Spain and the western United States, on the other hand, have fostered the doctrine of prior use—protecting those who first put a stream to beneficial employment.

These doctrines have been modified by judicial decisions and by interstate compacts. Now, it is evident, we need another and more flexible doctrine of equities in water, another and higher law. It is no longer possible to regard either water or land as purely private property, unaffected with a public interest. Whatever the legal rights, no owner has the moral right to waste a natural resource or to put it to uses which are generally harmful. He is not entitled to burn his own forests, allow his own land to be forever impoverished through the washing away of the fertile topsoil, or permit his streams to contribute an unnecessary drop to a major flood.

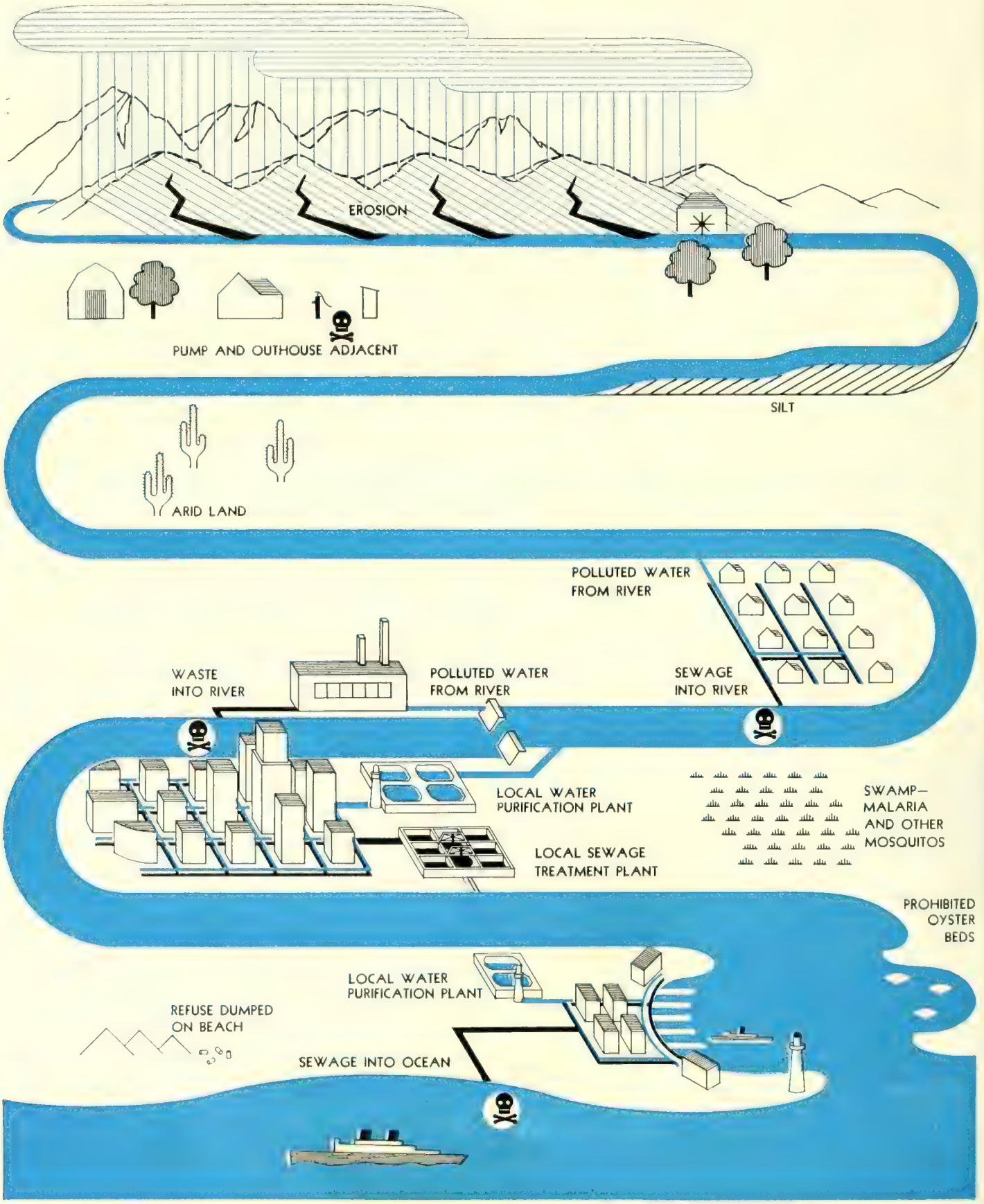
Similarly, no neighborhood has a moral right to follow water policies which will injure other neighborhoods, nor has any State or region a right to impair the general good. The Golden Rule is no fantastic dream in the use and control of water. It is the only rule that makes good law and good policy.

In the interests of the national welfare there must be national control of all the running waters of the United States, from the desert trickle that may make an acre or two productive to the rushing flood waters of the Mississippi.

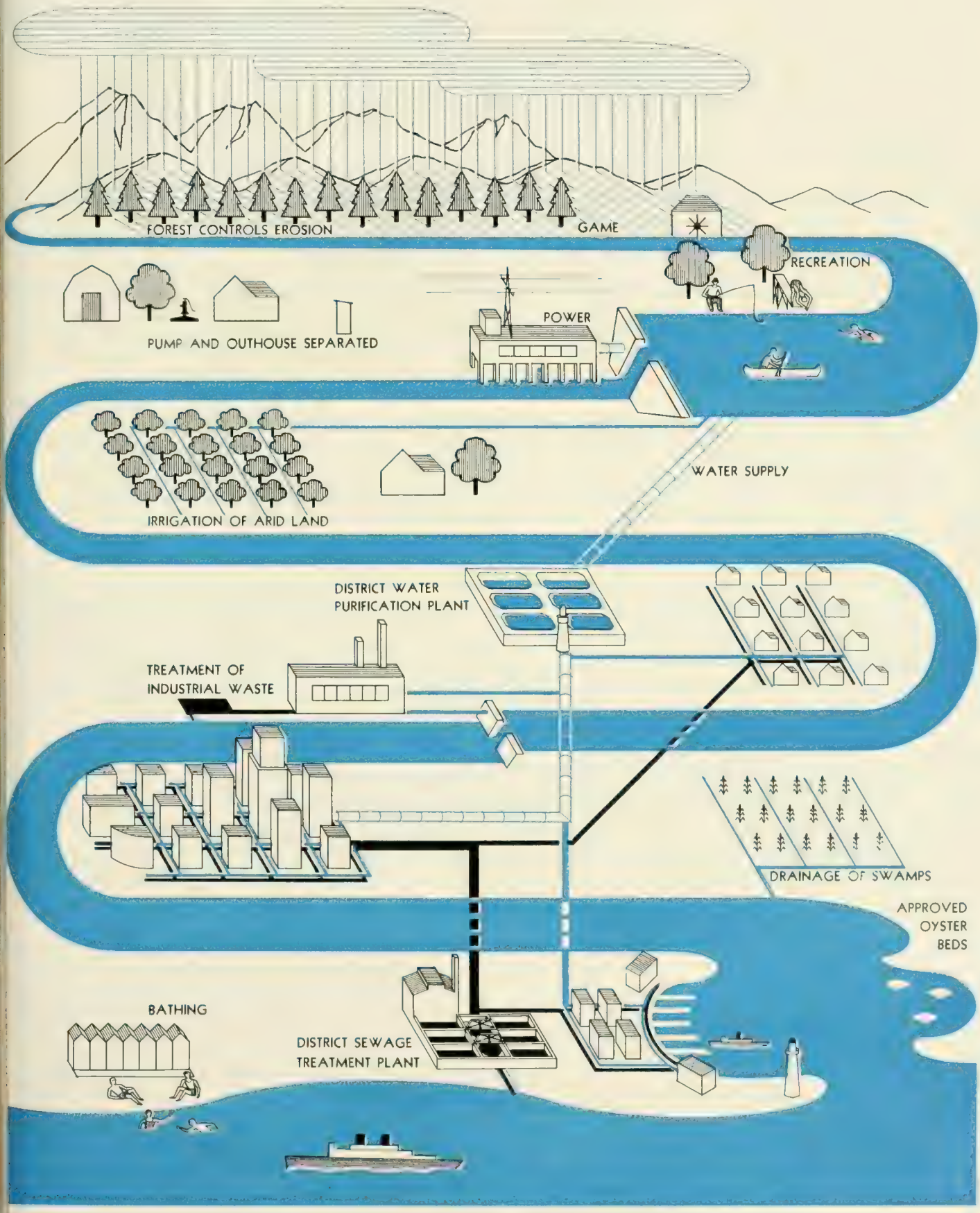
To say this is not to say that we must have a water dictator in Washington. The Nation is not the Federal Government alone but the State and local governments and the people who are citizens in all governments. What can be done locally should be done locally. What can be done by a State should be done by a State. What can be done by groups of States should be done by groups of States. The residual problems, too vast for any other agency, must devolve upon the Federal Government. In every case the ultimate and remote outcome, as well as the near and immediate, of every step taken must be considered. The uses of water are many. They must be balanced against each other if the most effective results are to be attained.

The task of making and carrying out a national water policy will involve many agencies, some existing, some which must be created. It will take a long time. It will demand the highest order of statesmanship and patriotism. We believe that America cannot and must not shrink from the challenge. Here, as in other things that we do and plan, our children's children should have cause to thank us—not to reproach us.

Unplanned River Development



Planned River Development



PART III—SECTION I

PRINCIPLES AND POLICIES OF THE USE AND CONTROL OF WATER RESOURCES

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SECTION I
I. THE APPROACH

1. A Human Problem

Man's achievements in the physical sciences, and in the arts of communication, transportation, and mechanized production, have led to the frequent assertion that he has conquered nature. This assertion is too sweeping. "Civilization is not an enslavement of a constant and stable earth." Man does not conquer the earth, but strives to enter into a harmonious relationship with it. Generally he is conspicuously successful; but sometimes he effects only tolerable relationships, and occasionally his efforts are disastrous.

In some instances nature's ways have been so modified by inadequately planned works of man that now engineering and economic experience indicate the need of readjustment in respect to many of these relations; in some aspects a more intelligent conformity to certain basic, inexorable conditions imposed by nature; in other aspects a more intelligent utilization of her generous gifts.

These conclusions are impressively forced upon those who have made detailed studies of the use and control of the water resources of the United States. Water has been a major factor in giving us a high order of economic culture. In some regions this is the direct effect of abundant precipitation; in others it is the result of man's ability to compensate for niggardly precipitation by modification of nature's arrangements. On the other hand, there are instances of impairment of culture and of disaster to individuals resulting from imperfect adjustment of institutions to basic natural conditions. For instance, one generation may establish agriculture and build villages, cities, highways and other works directly in the path of a predictable flood that will inflict great loss on this or the next generation. Likewise, one generation may establish similar institutions in a region subject to occasional excessive droughts which wipe out the achievements of a lifetime of labor. Over a large area of the United States man's carelessness has so destroyed natural balance between vegetative protection and exposure of fertile, soluble topsoils as to impair through erosion the productivity of millions of acres of agricultural land. In some places he has permitted streams of pure, wholesome water, one of his primary necessities, to become converted to conduits of sewage and industrial filth. In other places he has made excessive drains on underground stores of water and at the same time upset natural provision for maintenance through infiltration by hastening the surface run-off directly to the rivers and the sea. Altogether, although water resources have contributed generously to a high order of economic culture, there is a considerable number of instances of regional and local maladjustments to water conditions that set up stresses and strains in the cultural structure.

These circumstances create a great human problem from the dual necessity of adjusting the available water resources to the use and convenience of man, and of adjusting man's activities to the limitations imposed by water resources. Many potential benefits which Nature offers have not been realized, and many benefits have been seized upon in such a manner as to jeopardize the economic security and welfare of numerous localities and individuals.

The relation of the great wealth of water resources in the United States to the pressing problem of creating the conditions for a stable and secure cultural life is fundamental. To minimize the menace of waters and to promote their greatest usefulness are objectives worthy of the application of the highest intelligence and other energies of the Nation. The problem is an engineering problem; not merely of physical engineering but of cultural engineering—of planning a future civilization. All that engineering has taught us in respect to planning must be brought to bear on this great problem.

Planning for the use and control of water is planning for most of the basic functions of the life of the Nation. We cannot plan intelligently for water unless we consider the relevant problems of the land. We cannot plan intelligently for water and land together unless we plan in terms of collective interests. We are but tenants and transients on the earth; we should hand down our heritage unimpaired—yea; enriched—to those who come after us.

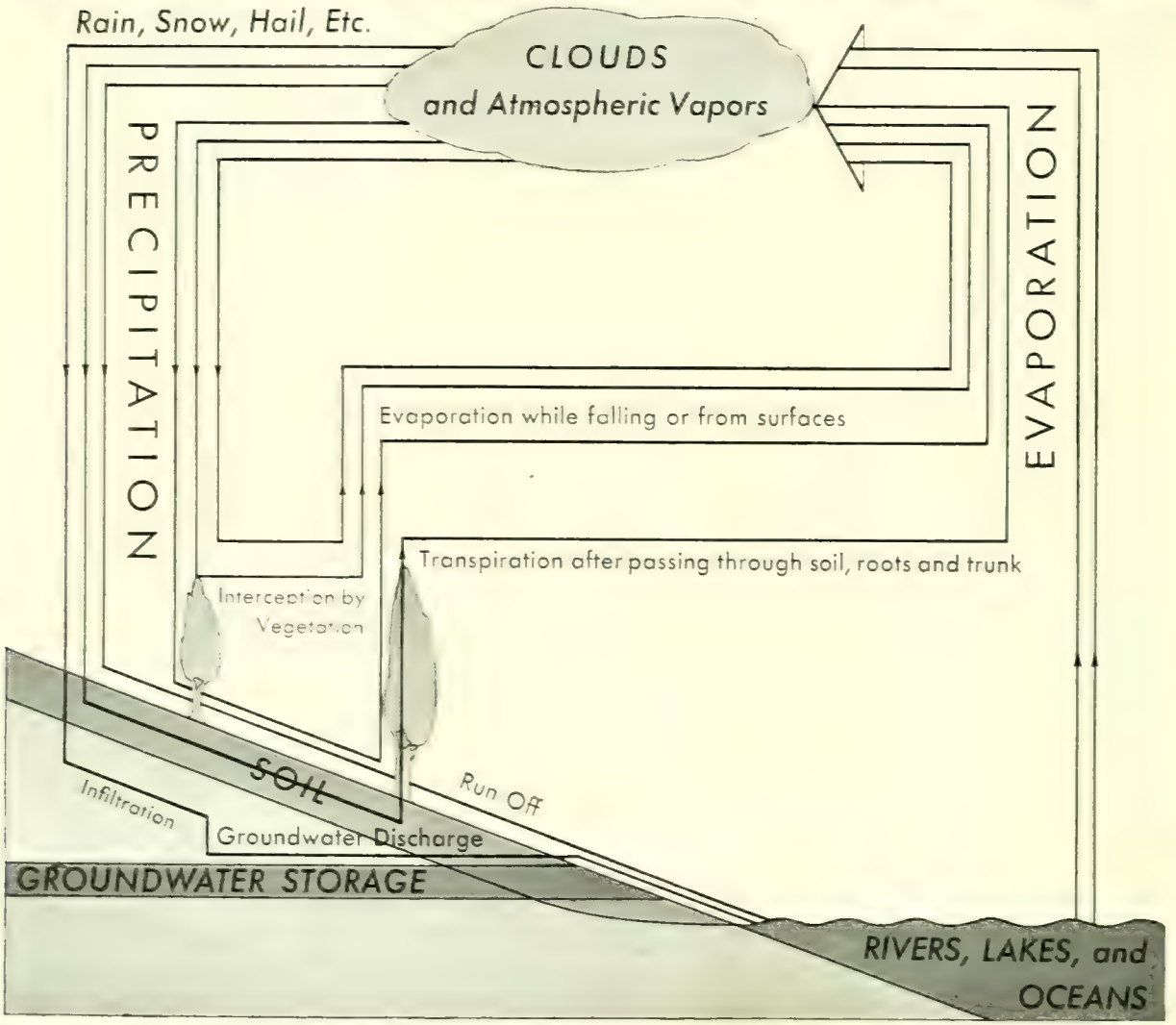
2. Four Unities

The key to the beneficial control and use of the waters of the country is to be found in recognition of four unities. Each is an integral whole of related variable factors, and each is related to the other.

(*a*) *Unity of Physical Factors:* From the rainfalls and snowfalls at headwaters of great river systems to the floods on the lowlands at their mouths, and in respect to every influence manifested by waters between these

Above, source of runoff in the Rocky Mountains. Below, destination of runoff in Cypress swamps of the South.

Precipitation and the Hydrologic Cycle



PICTORIAL STATISTICS, INC.

NATIONAL RESOURCES BOARD
WATER RESOURCES SECTION

PRINCIPAL PHYSIOGRAPHIC DIVISIONS
OF THE
UNITED STATES

Scale 1:8,000,000

100 0 100 200 300 400 500 600 Miles

points of origin and destination, there is a complex of relationships and interdependencies among water factors, and between water and other physical factors. Coincidence of unusual precipitation in the Appalachian area with unusual precipitation in the southwest Mississippi basins causes the great destructive floods of the lower Mississippi. Coincidence of droughts in opposite sectors of a large drainage basin may cause low water in the main river and many of its tributaries, and shortage for widely scattered users. Excessive channeling of waters directly to rivers may cause diminution of infiltration and of ground storage, diminution of retardation and seepage into streams, ultimately reflected in excessive low water in dry periods. Excessive drainage of numerous natural water reservoirs, from small ponds to lakes of considerable size, may contribute to the same effect. The removal of vegetative cover may upset natural balance, increase the rate of run-off, and sometimes cause increase of flood damage. Excessive tillage of uncovered soils may promote the washing of fertile top soils into streams, leaving infertile subsoils and rocks unsuitable for agriculture. In some places, in the vicinity of the upper one hundredth meridian, the highest usefulness of the physical resources to man depends on maintenance of a nicety of balance between water factors and between water and other physical factors. By and large nature had, before the advent of man, developed some measure of balanced relationship between all these physical factors, and it is to man's interest to discover what these natural relations are, which of them may be modified to his advantage, to which he should conform, and to make his cultural adjustments accordingly.

(*b*) *Unity of Man's Interests:* This integrity of physical characteristics therefore compels a unity of human interests in the use and control of waters. For a time, in the period of early settlement and sparse population, the individual community's handling of waters in its sector of a system may be entirely beneficial to itself and without injury to other communities. But when settlement becomes intensive and the population relatively dense, the increase of uses of water and of claims on a system changes the situation completely. The local benefits that at first result from individual community acts, come gradually to be accompanied by disadvantages to other communities; and eventually it frequently happens that the aggregate of collective disadvantages outweigh the aggregate of localized benefits. Then collective interest emerges; interest in unified plans for developing the use and control of a system, in unified physical engineering, and in unified financing.

(*c*) *Unity of Responsibility:* Where unity of physical factors in a water system creates this unity of interest in their control and use then unity of responsibility in respect to control and use must follow. As here employed, the terms emphasize different aspects of the same thing. If it is to the common interest that streams be regulated—that run-off be retarded, erosion reduced, the water table maintained at a most serviceable level, flood flow reduced if possible and at least confined, waters kept free from pollution, navigability promoted, water power utilized to maximum advantage, recreation facilities conserved and expanded, and so on —the very integrity of the physical factors of a system and of the cultural interests compels common responsibility for action in treatment of the system. This common responsibility is generally of three kinds: Common individual responsibility in conduct toward the water resources in accordance with rational standards, as in reduction or amelioration of pollution by sewage and waste treatment; responsibility for consolidated action in reducing hazards by regulating works, such as levees and reservoirs; and responsibility for consolidated action in realizing new and collective benefits, such as the generation of power. Economic status is a phenomenon of social life, and proper use and control of water resources has come to be a phase of the collective problem of maintaining and enhancing the economic position we have achieved.

(*d*) *Unity of Action:* It should be obvious that because of these unities of relationship between physical factors of human interests and of responsibility there must be unity of action if man expects successfully to effect the most beneficial adjustment to his natural environment. The cross purposes, interferences, and other weaknesses of individual efforts must be eliminated. The only way to eliminate them is by application of the intelligence of the people and of other forces in an organized manner. A collective mind must attack the problem, and plan and carry through the solution. It may execute through various groups, and even through individuals, of course; but it is a collective mind that must evaluate the problem, propose the master social objective, define constituent objectives, organize ways and means, and effect those coordinations in adjustment to natural environment which the increasing complications of social life make imperative.

3. A Problem of Multiple Adjustments

Interrelations of physical factors, interests and responsibilities make the development of the use and control of water factors a problem of coordination from several points of view. It is this multiplicity of coordinations that makes the problem a real challenge to intelligence and to capacity to plan.

(*a*) *Multiple Uses:* It has been the custom generally to approach a water factor as presenting only one specific problem of control or use; for instance, elimina-

points of origin and destination, there is a complex of relationships and interdependencies among water factors, and between water and other physical factors. Coincidence of unusual precipitation in the Appalachian area with unusual precipitation in the southwest Mississippi basins causes the great destructive floods of the lower Mississippi. Coincidence of droughts in opposite sectors of a large drainage basin may cause low water in the main river and many of its tributaries, and shortage for widely scattered users. Excessive channeling of waters directly to rivers may cause diminution of infiltration and of ground storage, diminution of retardation and seepage into streams, ultimately reflected in excessive low water in dry periods. Excessive drainage of numerous natural water reservoirs, from small ponds to lakes of considerable size, may contribute to the same effect. The removal of vegetative cover may upset natural balance, increase the rate of run-off, and sometimes cause increase of flood damage. Excessive tillage of uncovered soils may promote the washing of fertile top soils into streams, leaving infertile subsoils and rocks unsuitable for agriculture. In some places, in the vicinity of the upper one hundredth meridian, the highest usefulness of the physical resources to man depends on maintenance of a nicety of balance between water factors and between water and other physical factors. By and large nature had, before the advent of man, developed some measure of balanced relationship between all these physical factors, and it is to man's interest to discover what these natural relations are, which of them may be modified to his advantage, to which he should conform, and to make his cultural adjustments accordingly.

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tion of a flood hazard, or navigation, or irrigation, or power. Study of many situations indicates, however, that frequently the combination of factors is such that achievement of some particular objective may be promoted by combining other objectives with it. Usually a project is conceived because of some one hazard or of some one desired use; but if a large view is taken it becomes apparent that other uses are potential and should be included in the project, in order, on the one hand, to secure the greatest total benefit from the natural resource, and, on the other hand, to make the cost of each component benefit less than it otherwise would be. Many projects have been reviewed by the committee which, although inspired by a single purpose, offer excellent opportunities for combinations which would multiply benefits and reduce the cost of any one benefit below what it would be if sought by itself. Thus a project may at first appear to involve only the element of levee or reservoir control of floods, but careful consideration may disclose that reservoir control may carry with it opportunities for power generation, water supply for adjacent communities, and recreational facilities. In exceptional instances the same dam and reservoir may be made to serve flood control, irrigation, power, and recreational purposes. A dam conceived at first solely for navigation control may offer also power generation. No matter what the originating purpose, every other reasonable purpose should be considered in defining and planning a water project.

(*b*) *Water and Other Physical Factors:* In respect to some problems the significance of water aspects of the problem is realized only when considered in relation to other physical factors. For instance, one of the most important problems of water—erosion—involves consideration of vegetative cover, and of forest and farm practices which affect it. So also does the problem of low water, adequate supply of suitable water for domestic and industrial uses, and safe discharge into streams of sewage, and of industrial and mine wastes. Many water problems involve consideration of such other factors as temperature, evaporation, topography, and even the composition and structure of the outer portion of the earth's crust.

(*c*) *Water and the Practical Arts:* In many instances water problems are created or their solution conditioned by the practical arts which man has developed. This becomes clear when one studies the problem of erosion—again cited because it is so widespread and harmful—wherein the nature of agricultural practice has had a strong and destructive influence. In respect to stream pollution, municipal sanitary and industrial waste disposal practices have had harmful influences. Incomplete and unintelligent evaluation of many drainage undertakings has led to population movements and impossible agricultural efforts which have in places dissipated men's resources and broken men's spirits. Solution of such problems requires either an adjustment of water controls and uses to established practices, or, more likely, a reconstruction of practices in adjustment to the water factors.

(*d*) *Water and Political Institutions:* Man has established institutions for promoting social adjustments in livelihood and other activities. A Federal system of Government is somewhat complicated and is not very flexible, and at times development of its adaptability to effective control of collective affairs may lag behind development in the complexity of the affairs which must be controlled. However, the Federal, State, and numerous local governments are the basic institutions through which collective purposes must be accomplished in the United States. Inasmuch as water systems and water problems involve large areas and have no respect for political boundaries, there arises the problem, in respect to the use and control of waters, of a rational and effective coordination of the authorities and activities of the various governments, and possibly the creation of new agencies by them individually or jointly. This is perhaps the largest and most difficult of all the problems of coordination.

(*e*) *Water and Public Scientific Agencies:* Within each component government of the Federal system exist numerous agencies of a scientific-educational nature which have to do with water resources or whose activities touch water factors. Geological, weather, agricultural, forestry, navigation, health, and many other bureaus and divisions of bureaus of the Federal Government and of the States are conducting researches, publishing data, directing educational campaigns, and even suggesting specific policies and activities which affect water as well as other resources. Their functional purposes and activities should be better coordinated in order that there may be realized a more complete and consistent collection of scientific data, greater consistency in policies and activities recommended, and more constructive results from the total activity. Especially is this necessary if there be sought coordination of governmental activities in development of the control and use of water resources over areas which transcend State boundaries.

(*f*) *Water and Culture:* Any particular use of water resources is a particular aspect of culture, and may be made to reinforce or impair related aspects of culture. The appropriation of a water front by a railroad or by industrial concerns may deprive a community, as in New York City, or a large number of communities, as throughout much of the length of the Hudson, of important recreational and esthetic resources. One reason why European water fronts are frequently more beautiful than most of those of the United States is that

cultural uses were established before mechanization came upon the scene. An appropriation of resources for a single cultural use may have been justifiable under earlier conditions in the United States, but in the future the requirements of all aspects of culture should be given consideration. Sewage and industrial wastes may render streams and ponds unfit for water supply and industrial uses, and for recreation. These agencies have destroyed fish life in many streams, and occasional unwise drainage has destroyed wildlife on a larger scale. The increasing complexities and strains of modern life have made physical and mental health a matter of public concern, and recreation is now recognized as an element of major importance in cultural life. It is necessary in planning the use of water resources to give adequate consideration to the part they must play in creating opportunity for wholesome recreation.

Situations exist in which the development of a water resource, or the elimination of water hazards, may be made the focal point of reconstruction of the culture of a backward region. A culture which has been conditioned by factors which have long ago disappeared and has continued because of inertia, may be brought within the influence of a large program of control or development of water resources and be given a higher status.

(*g*) *Benefits and Costs:* In the large, natural resources are benefits bestowed on man by nature. But generally their control and their adaptation for particular uses and enjoyments require arrangements and manipulations. Arrangements and manipulations involve costs of various kinds. Benefits may accrue to particular individuals in a measure greater than that in which they accrue to other members of a group. Likewise costs may fall on particular individuals in a degree greater than they fall on others of the group. Adjustments of benefits and costs, both total benefits in respect to total costs, and individual benefits in respect to individual contributions, is an important aspect of the problem of development of water resources. Many benefits, and perhaps many costs, are intangible. While it is good policy to have regard first for the relation of tangible benefits and costs, it is of importance to recognize and develop a technique for discovering and appraising intangible benefits and costs, and to give them proper consideration. Coordination of benefit and contribution to cost cannot be equitable until intangibles are recognized and evaluated. This is one of the most important problems attached to the larger problem of development of public works.

(*h*) *Other Coordinations:* There are other coordinations which, although of fundamental importance, cannot be considered separately. However, they are of a common order and are related. One is the harmonizing of personal liberty and group control—of evolving a democracy which can realize both the satisfactions of personal independence and the efficiency inherent in organization. Water problems are collective problems; collective problems can be solved only by organized, collective efforts; organization requires functional authorities and functional obediencies. The solution lies undoubtedly in recognizing that there are "laws inherent in situations", and that these laws can be obeyed without impairing the essential qualities of democracy.

Another important coordination is that between planning and spontaneity. Spontaneity is an inherent natural mode of self-expression and has incalculable values. Yet because collective objectives cannot be achieved without collective action, spontaneity must give some place to calculation, planning, and arrangement. The solution here appears to lie in replacing spontaneity by planning where collective objectives require it, and expecting compensation by such a consequent control of environment as creates an even larger area for individual freedom and spontaneous self-expression. It is rational to suggest that through organized, collective action restrictions of inanimate nature may be removed in much larger extent than human restrictions are imposed, and that the net result will be enlargement of opportunity for individual freedom and initiative.

SECTION I

II. LINES OF ACTION—BASIC CONSIDERATIONS

Whatever the specific projects which might be decided upon in a program of development of the use and control of water resources, certain continuing fundamental activities would be essential.

1. Research, Investigations Inventories, Surveys

Many individual water projects have come to the attention of the committee; in most instances the supporting data have been incomplete and in many instances they have been inadequate. Some of the lacking data are of a purely hydrologic nature; some pertain to the cultural life of a region concerned; some pertain to the particular physical characteristics of the project itself. This experience indicates the urgent need of various kinds of continuous researches and of investigations.

First may be placed the need of more complete and better coordinated records of hydrologic data, especially the establishment at all strategic points of continuous records of precipitation, run-off, underground water, and so on. More such data are needed as elements in determining policies, programs, and projects. Such intensive studies might well be made as that of the apparent lowering of the ground-water level, the factors affecting low water flow, or even, perhaps the influence on precipitation, if any, of evaporation from decentralized ponds and lakes, and from vegetative covering.

Second, not unrelated to the collection of data recommended above, there should be as complete and fairly detailed an inventory as is practicable of all the water resources of the country—rivers, lakes, ponds, swamps and marshes, and underground stores. Water resources should be labeled in respect to their quantity and more important qualities—chemical and physical properties, uses for which suitable, and so on. Such a physical inventory is essential to any comprehensive planning of development and use.

Third, there should be continuous investigating of possible project areas and of promising specific projects. This is particularly essential if public works that include development of water resources are to be held quickly available as a gap-filling activity to maintain a more stabilized industrial trend. Water projects are of such a nature that generally they cannot be mobilized in time to be of service in any emergency plan of regularization unless project areas and projects have previously been discovered and defined, and basic engineering surveys made.

In the fourth place, therefore, determination of future desirable projects should be followed immediately by detailed surveys which result in basic designs which in time of need may be taken from the files, revised, and promptly utilized to get work under way. There are project areas in which the need of future dams is unquestionable. The future need having been determined, at least the basic surveys required for working out the nature and location of the dams should be made promptly—detailed topographic maps, borings, and so on. Complete designs could be made in a relatively short time in case of emergency, provided the basic data from detailed surveys are in hand.

Finally, because of that enrichment of man's knowledge and eventual increase of his creativeness in practical affairs which comes from pure research, these data of which the continuous collection has been recommended should be made available in all centers where researches in the field of hydraulics are being carried on, and such researches should be otherwise promoted.

2. Standards of Water Use

In respect to laws and practices governing the use of water there is considerable variation throughout the United States, and every effort should be made to bring about conformity to accepted principles and uniformity of practice. The doctrines relating to equities in waters are not the same in all the States. The development of water resources on the basis of drainage areas requires a harmonizing of such divergent views. Improved standards concerning the tolerance of industrial and mine wastes and municipal sewage in streams could be worked out. Improved practices concerning the uses of subsurface waters, where they are a critical factor, would be helpful. Of great importance is the development of standards of rational procedures in respect to farm practice, and its influence on run-off. Uniform principles governing drainage, forest practice, and reforestation, are among other possible standards. Principles and standard practices of Federal participation in and contribution to regional and State water projects could be formulated. It is true, of course, that the Federal system makes difficult the rapid establishment of such uniformities, but that fact makes only the more urgent the prompt establish-

ment of a vigorous educational campaign toward the elimination of as many variables and inconsistencies as possible.

3. Instruments of Action

Whatever lines of action constitute a program, instruments of planning and of execution must be employed. It is desirable at once to make a study of existing and potential institutions—the Federal Government, States, compacts, authorities, districts, conferences, and so on—to determine the suitability of each for functions involved in any program or project of development of water resources. While final determination of the functional competence of each in respect to water use and control must come from experience in utilizing them in that field, past experience with their use in other kinds of collective action may suggest the probable suitableness of each for the new field. If certain instruments which are difficult to bring quickly into being—say an interstate authority or an intrastate district—are found to be highly desirable, then among the standards noted above might be uniform State laws and basic Federal enabling acts which establish standing authority for speeding action in the creation of desirable intrastate and interstate instrumentalities.

4. Equities, Benefits and Costs

A considerable obstacle to a comprehensive public-works program is the reluctance of communities to assume their share of the costs. The problem of equities, benefits, and costs is a complicated and difficult one, and one of the most important fundamentals of action is the formulation of general principles governing the relations between them. This involves studies in social as well as in private accounting. Especially is it desirable to initiate promptly the study of the part played by intangible factors, for some equities, benefits, and costs may be intangible. Complicated factors of cultural and economic relationships would be involved in such a study, but it appears reasonable to explore the possibility of constructing a generalized formula which would serve in any particular project by substitution of ascertainable values for such of the terms of the formula as are pertinent to the particular project. It is also highly desirable to investigate the need of revision of conventional costing technique; to discover a technique peculiarly suitable to collective undertakings which attaches major weight to basic elements of cost such as labor and materials, and less weight to costs arising out of individual privileges and rights, which makes new evaluations of the elements of cost when there is employed creatively labor which otherwise might have to be provided subsistence when idle.

5. A Technique of Collective Planning

The complex of relations—physical characteristics, interest, and responsibilities—in respect to the development of the use and control of water resources, and the scale and cost of operations involved, requires that developments be not undertaken casually, but in a predetermined manner. There must therefore be evolved, on behalf of all the various interests concerned, a suitable technique of planning. The most helpful experience which may be consulted for that purpose is the experience of private industry—in both engineering and fabricating operations—which has developed a technique of planning and execution of operations on a scale of comparable type.

It must be recognized, of course, that the motives and objectives of private industry are different from those of a government. But the difference relates almost entirely to objectives. Given two programs involving dam and reservoir construction, one decided upon by a private industry for its individual purpose and the other decided upon by the Government for its collective purpose, the basic technique of planning and execution should differ only as required by the technical differences in the operations. The techniques should be the same fundamentally. Industry has developed a technique of planning suitable for any type of purposive effort, no matter what the auspices and what the objective. Its use by governments has been restricted chiefly to military operations, but it is adaptable to other public purposes and does not require military regimentation.

Two features of industrial planning should be noted particularly. One is that planning for a continuing institution, private or public, cannot be the responsibility of an individual. There must be what is sometimes called a comprehensive mind—a unit composed of individuals who come and go, but which still has a life coincident with the life of the institution; which has its powers of perception (recording, research, investigation), of memory (records) and of reasoning (analysis of data) and which can assemble data, draw conclusions, devise ways and means, and organize complementary efforts of execution, with respect to any particular project, on a scale and with a precision beyond the capacity of any individual. Effective planning of public works involving the control and use of water resources should be done by such a comprehensive mind.

A second noteworthy feature of industrial planning, as developed by multiple-plant corporations, is that the comprehensive mind is divided into functional planes. One plane is concerned with directive planning, which coordinates the purposes and activities of major units of action, but not with the more detailed activities

within these major units. Another plane is concerned with general administration of a major unit, and under the environmental controls of directive planning, coordinates the purposes and activities of its constituent units. A third plane is concerned with operative planning, a coordinating of the details of purpose and action of each ultimate operating unit. The more remote a plane of planning is from the scene of action the less it is concerned with details and the more with environmental controls.

The framework of such a technique of planning could undoubtedly be adapted to planning of public works; and in such an adaptation existing institutions, such as the Federal Government, States, authorities, districts, private enterprises, and so on, be given their logical and legal place within the organization both for planning and for execution. It would undoubtedly be necessary to establish a plane of directive planning responsible for the development of all resources, and then a plane of directive planning responsible for each of the major classes of resources (lands, minerals, waters) and under each of the latter, agencies for general administrative planning. These general administrative agencies would organize their respective subagencies for detailed operative planning. The committee believe that the casual, costly development of the use of resources in the past can be replaced by one which will be more orderly and auspicious only through the adaptation of some such technique of planning. At the end of section V will be found a suggestive organization chart for an agency to plan the development and use of water resources.

6. Democratic Planning

It should be recognized that the essential value of democracy must not and need not be sacrificed in the development of such a planning technique. The planning agencies can be established as functional servants and not as independent authorities within a democracy. But when a nation through constituted authority has assigned to a planning servant an objective, the assignment must carry with it the authority to utilize ways and means in the planning in a manner required by achievement. The United States today is not the simple frontier democracy of a hundred and fifty years ago; it has become a very complicated institution in which some elements act in a manner harmful to other elements and to the whole; and it must organize its conduct in a manner to meet the new conditions. In this necessity democracy is facing one of its greatest tests. It must devise a way to plan and organize its activities in a manner which will achieve desired social objectives, and at the same time preserve equity in participation, equity in benefits, and equity in burden.

III. LINES OF ACTION—PHASES OF THE WATER PROBLEM

1. Water on Land

(*a*) *Precipitation, Run-off, Infiltration, Evaporation:* The more significant phases of water on land are precipitation, run-off, infiltration, and evaporation. Precipitation is beyond the control of man, and there is not yet evidence that he can influence it even in some slight degree. The records which have been kept during the century of clearing of forests and conversion of sod lands to tillage, have not been sufficiently analyzed to indicate whether and to what extent these operations have had influence on precipitation. There are theoretical reasons for believing that restoration of forests and grass lands and of decentralized ponds and lakes, with their influence on retention of water and its evaporation, might have some effect on precipitation, provided the distribution were vast enough for an interchange between large areas. Evaporated waters are rarely precipitated on the area where evaporation has taken place. Experiments on an adequate scale are probably impracticable. For present policy we must accept rainfall as it occurs with due allowance in our calculations for variations from "normal", which are extremely important in semiarid regions, and adjustment should be made through wise selection of lands for the purposes which all considerations, natural and cultural, indicate they are adapted.

Run-off can be controlled to a considerable degree, and where it cannot, some of its harmful effects can be diminished, especially by revision of certain farm and forestry practices to be discussed later.

This is a very important problem, for some rich top soils, when tilled and exposed to heavy rains, are easily washed into the streams where they are no longer of use in agriculture and complicate problems of regulation and control of stream flow. The extreme gullying form of erosion, although widely prevalent in some upland sections, is not extensive on large portions of the cultivated areas; but over large areas gradual sheet erosion is washing top soils away in a manner which has already become serious, and which threatens the survival of agriculture in some sections which in the past have been highly productive.

(*b*) *Underground Water:* The water which passes beneath the surface of the ground by percolation is of great importance to man. All vegetation depends upon soil moisture, and the water supply of one-half of the people of the United States is supplied from ground water through wells.

There is little evidence of serious depletion of these waters in the humid regions of the East and South, though the allocation of pumpage has become necessary in certain industrial regions, as in New Jersey. In the great agricultural regions of the Midwest and Northwest, however, the depletion of soil moisture and the falling of ground water levels has become critical. Undoubtedly this is the result chiefly of severe and prolonged droughts, though cultivation and usage are probably responsible in part.

The need for large scale, long time, scientific planning is eminent. Water conservation, land zoning, and improved farm practice are indicated. Important in connection with water conservation is the provision of the best available water for farm, city, and industrial supply. Through the application of geophysical principles to water prospecting, a supply of clear, clean, cool ground water may be secured for many who are now using highly polluted surface waters.

Next to natural springs, artesian wells are in many parts of the United States the most economic means of recovery of ground water for man's use. They are of especial value to stock interests in both grazing and diversified farming on account of the unpumped flow of an unpolluted stream, relatively cool in summer and warm in winter.

Because of careless drilling and finishing of wells, unrestricted flow, and failure to control old and "wild" wells, the supply of artesian water is being rapidly exhausted in some regions. There may result also the flooding of valuable land with mineralized water, and much damage to highways through drainage into roadside ditches.

Conservation of underground water from both deep-seated and shallow horizons should be enforced through the proper construction of wells, the elimination of waste, and where needed, the determination of preferential usage. This would not only save the pressure and water but would prevent valuable farm land from becoming "salted" and good roads from saturation.

(*c*) *Land Use—Zoning:* Because on the whole precipitation, run-off, and underground storage can be only slightly influenced by man, his policy relative to water on land must be concerned primarily with the manner in which he accepts nature's conditions and turns them to his best advantage. Man's relations to water on land are a function of his relations to land itself. Therefore it is essential that his utilization of

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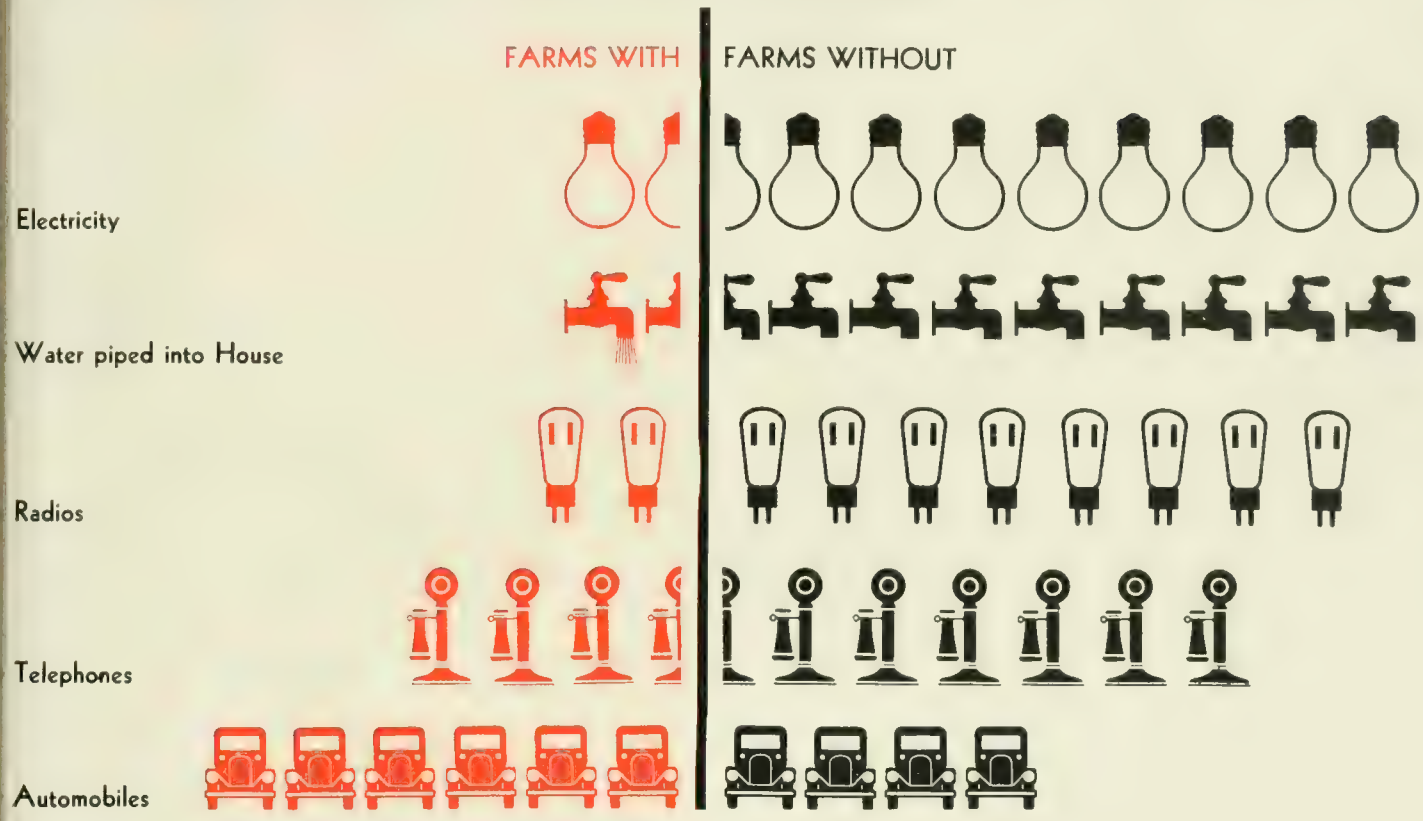
land have regard for the water factors as a whole and as attached to any particular sector of it. His first consideration in respect to this requirement relates to land use in its general aspects. An inventory of lands should be made as to topographic, soil, temperature, water, and similar characteristics. In many instances water will be found to be an important, and in some a dominant, characteristic. Everything taken into consideration—especially topography, soils, and water factors—rational judgment will decree that arrangements be effected whereby each area is put to its proper use in a setting of total proper use. Some lands will be restored to vegetative cover—forests, grass, and hay—and some to a natural wet condition, in order not only to secure indicated products but also to retard the run-off of basins and regulate stream flow and water supply. Some areas having fertile soils will be drained and those having infertile soils left in their wet state; and perhaps some already drained but infertile will be restored to their original marshy or swampy condition for the benefit of wildlife. Judgment will dictate that on the whole only the best lands in respect of topographic, soil, and water factors in combination will be employed in agricultural operations requiring tilling of the soil. If circumstances at any time call for increase or decrease of tilled lands, a proper inventory will permit lands outside the margin to be incorporated, or those just inside the margin to be put to nonagricultural uses. In this manner a basic flexible adjustment to natural conditions can be effected, and a higher culture and welfare achieved.

The related rural zoning and severance tax laws of Wisconsin together are an example of pioneering application of the principle which it is here suggested might advantageously be applied on a regional or national scale; so also is the Kansas remittance of $40 of taxes on farms having a prescribed number of acre-feet of impounded waters. The Wisconsin laws appear to have been inspired in part by a desire to relieve counties of the mounting burden of providing educational highway and similar services for scattered marginal districts, and by a concept of a generally better utilization of lands, including reforestation. The severance law, at the option of an owner, relieves growing timberland of all current taxes except a limited levy of 10 cents per acre, but at the time of cutting imposes a tax of 10 percent of the stumpage value of products cut and removed. This encourages reforestation. The zoning law, the result of a series of acts begun in 1923, provides that "the county board of any county may by ordinances regulate, restrict, and determine the acres within which agriculture, forestry, and recreation may be conducted, the location of roads, schools, trades, and industries, and the location of buildings designed for specific uses, and establish districts of such number, shape, and area, and may also establish set back building lines outside the limits of incorporated villages and cities, as such county board may deem best suited to carry out the purposes of this section. For each such district, regulations may be imposed designating the trades, industries, or purposes that shall be included or subjected to special regulations and designating the uses for which buildings may not be erected or altered." Several counties have already enacted, and many are preparing for, zoning ordinances, but it should be noted that what many authorities consider the major weakness in the law is that zoning is not mandatory and depends upon the initiative of a county. Planning and land-use commissions are engaged in stimulation of such voluntary efforts and in suggesting improvements in the laws. Already examples have been created of the purpose of such laws; the compacting of settlement, getting farms closer together on the better lands, reducing the unit cost of public services, and thereby giving agricultural communities better service. Similar legislation being developed in Minnesota may provide in one way and another more opportunity for expression of the interests of the State. The significance of such legislation from the point of view of this report is that it promotes better utilization of or adjustment to natural water conditions as phases of the land-use problem.

(*d*) *Farm Practice:* Most serious as setting conditions for erosion is the conventional farm practice which has developed in the United States—tilling and exposing slopes particularly susceptible to washing, plowing without regard to contour, draining hollows that formerly served as catch basins for replenishment of ground water, and so on. The zoning and wiser selection of lands for various uses, noted above, would remedy this in part, but far from sufficiently. Appropriate measures must be taken to instruct farmers in respect to the seriousness of erosion, and to induce new practices—contour plowing and diking, terracing, mulching. These measures cannot be arbitrary, but by instruction and demonstrations something can be accomplished, and much more by such measures as tax reduction or bounties for effective revisions of practice. The problem is one of the most serious among those confronting the United States today, and adequate steps toward its solution should not be delayed.

(*e*) *Irrigation:* One of the most beneficial uses of water on land is through irrigation, especially in arid regions where the raising of crops is wholly dependent on irrigation, and in humid sections where a particular crop (e. g., rice) requires application at critical times of large quantities of water. The promotion and management of irrigation in the United States have not been rational—in many instances its need has not been rationally determined and its methods have not been

Farm Modernization in the United States



Each Symbol represents 10% of all Farms equipped with Electricity, Water, Radios, Telephones, Automobiles

properly established. It is the judgment of the committee that for the present new irrigation projects be not promoted, at least pending the development of a carefully studied, comprehensive reclamation policy, whether the projects be Federal or private, and that present irrigation activities be devoted to establishing existing projects on a more serviceable and profitable basis. However, the committee recognizes that under any policy of selective land use, recommended above, it might result that withdrawal of relatively infertile lands from agriculture to forestry or grazing would warrant compensation through increase of tillable acreage by new irrigation projects on highly fertile soils in arid regions, or on soils requiring less consumptive use of water.

There is a type of irrigation which merits further study and experiment, and perhaps promotion. That is supplementary, or individual farm, irrigation in humid regions. It is a well-known fact that assured application of water to certain intensive crops at critical times in the growing season is far more beneficial than the chance application of the water by nature throughout the year, even though the total annual precipitation is abundant. And even humid regions experience drought in some seasons or in some years. With supplementary irrigation facilities a farmer can be more certain of his crop, and can expect a larger yield per acre. The problem is one of balancing the cost of supplementary irrigation equipment and operation against the gains. Inexpensive apparatus is being developed, and with cheaper power the movement may come to be of considerable importance. Every effort should be made to exhaust the possibilities, as it may be an important factor in a more decentralized industrial-agricultural economy.

2. Water in Streams

The principal problems of water in streams relate to water supply and sanitation, low water, power, floods, and navigation; and to conservation by storage. In the past these have been treated as more or less isolated problems; in the future they should be treated whenever possible in their relations. In general more research and study is required to determine these relations, the conditions and devices of water control, the conditions of multiple use, and uniformity of laws governing the use and control of water in streams. There should be developed a comprehensive policy and plans in which control and utilization are coordinated so that each may support the other, each bearing its share of ex-

pense and, if necessary, submitting its lesser requirements to the more important needs of other purposes.

(*a*) *Floods:* Floods are a destructive and dramatic manifestation of water's power, and hundreds of millions of dollars have been expended in efforts to control them. Control of such major floods as those of the lower Mississippi is already a national policy. However, a comprehensive policy of relations between Federal, State and other interests in a general attack on the problem has not been established. There are also required much additional observation and study of the relative merits of various control devices, such as improving the natural channel, levee restriction, storage and retardation, and combinations of these. Much study also is required to establish standards whereby to judge the merits of particular projects, the uses to be served, the costs, the benefits, and the manner in which flood control projects may be organized and maintained in order to bring these factors into an effective and equitable relationship.

Aside from the technical matter of constructing proper works, the most important problem imposed by the size and cost of flood-control works is calculation of benefits and equitable distribution of contributions to costs. There should be intensive study in respect to both of these elements; and especially a study of intangible benefits. The committee recommends the policy of requiring appropriate contributions from localities benefited as the most satisfactory general test whether a particular project is meritorious. As a basic policy until such time as studies here indicated suggest revision, it is recommended that Federal contributions be made (*a*) only where there is reasonable protection against maximum floods; (*b*) only where the total benefits justify the expense; (*c*) only where there are responsible and legally constituted authorities with which to deal; (*d*) to an extent not greater than 30 percent of cost of labor and materials where the benefits are chiefly local; (*e*) to an extent greater than 30 percent only in proportion to benefits definitely applicable to recognized national interests; (*f*) to a full 100 percent only where the benefits are almost wholly of national interest. The policy here suggested does not take into consideration either (*a*) any temporary or permanent public policy of Federal rehabilitation of distressed regions or (*b*) any temporary or permanent policy of providing employment relief in place of direct relief made necessary by technological or cyclic unemployment.

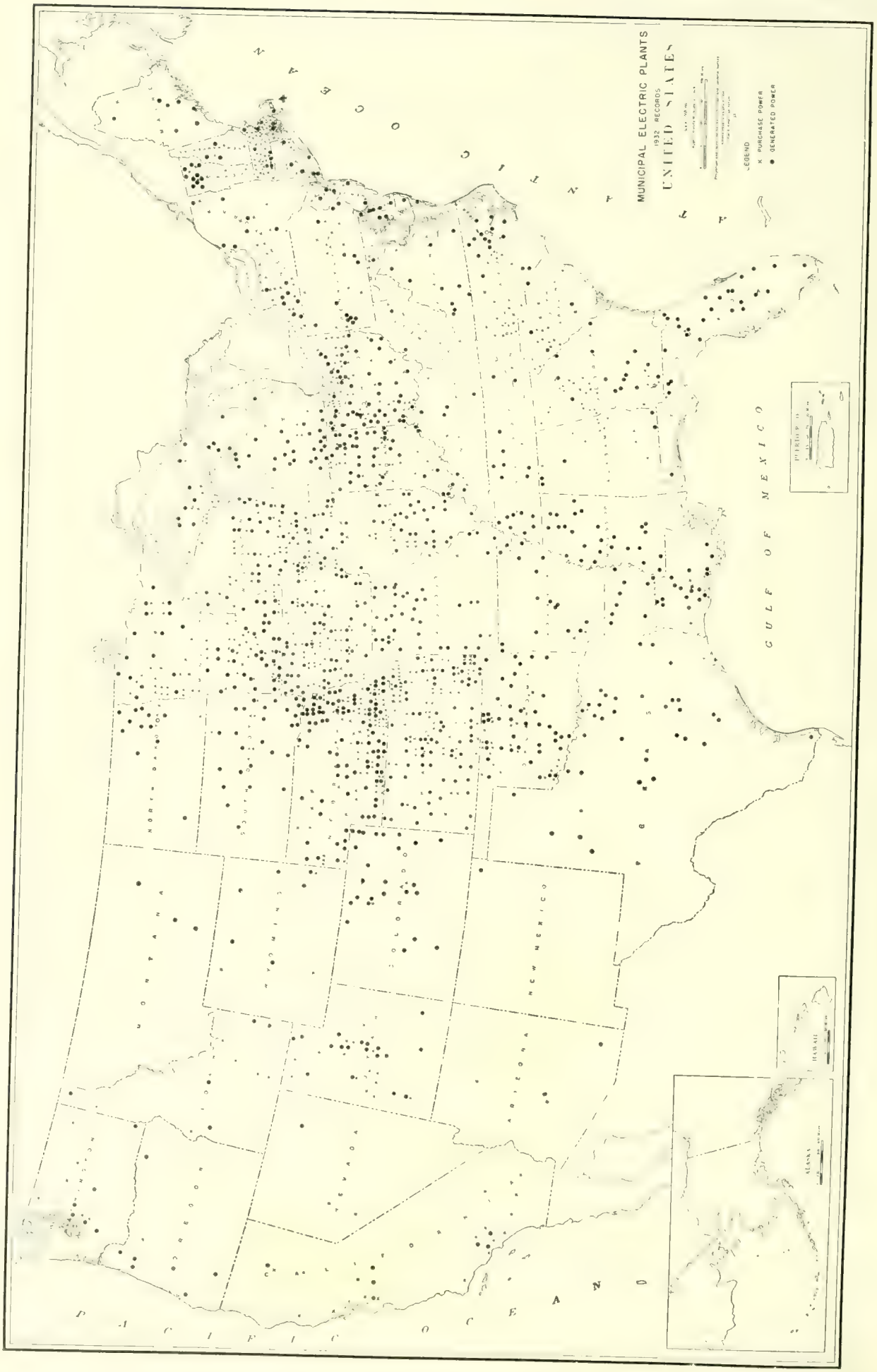
In further respect to flood relief, and to other projects comparable in extent, it is also recommended that (*a*) constitutional, legal and organization provisions be made for handling such problems on a regional basis determined by the drainage area involved, irrespective of political boundaries, and (*b*) that all projects include provision for all possible meritorious collateral uses, such as power, irrigation and recreation.

The havoc wrought in a flooded region is only partly revealed by the striking view on the facing page of an Alabama urban center under flood in 1929.

(*b*) *Low-Water Control, Water Supply, and Sanitation:* Such long-term records as are available indicate that there are alternating periods of greater and less precipitation and therefore of stream flow. There is little regularity in the length of these periods or of the variation from high to low. For convenience it may be stated that roughly the span from high to high or low to low is anywhere from 15 to 25 years. We are at present apparently near the low point of a period of decline. This decline is the principal reason for the problem of low water. It has undoubtedly been intensified somewhat by various practices; the drainage of run-off directly to streams, irrational drainage of some swamp areas, and the removal of forests and other vegetative cover; procedures which diminish infiltration and gradual seepage into streams. At the same time population and industry have been increasing, especially in communities located on streams. The increase of demand for water and the recurrence of periods of decreased stream flow have given rise to the problem of adequate supplies of pure water for domestic and industrial uses, and the use of streams for carrying away municipal sewage, industrial wastes, and mine wastes has given rise to serious problems of sanitation and public health. These are undoubtedly at present the most serious among water problems.

The solution lies, on the one hand, in extension of sewage and industrial-waste treatment practices, in order to remove or mitigate the principal causes of pollution; and, on the other hand, in restoration of vegetative cover, more rational drainage practices, and especially the establishment of reservoirs to restore and maintain a more even flow of pure water in streams and to improve the quality. Considerable progress has been made in many of the States, but there is little uniformity in the nature of the agencies and their powers. There is necessary a new orientation which conceives this problem as but part of a larger conservation problem, and as one involving drainage areas which are not coincident with any particular State boundaries. Federal contributions may well be made for such objectives, but only after localities have made all necessary provisions in respect to control of pollution and to interstate agreements. Problems of low water, water supply, and sanitation can be adequately solved only on a regional basis, as in the case of flood control from the points of view both of technical and financial requirements.

(*c*) *Navigation:* Dependence of early settlers on ocean ports and on internal waters for transportation impressed the Federal Government, and maintenance of harbors and waterways was early established as a


MUNICIPAL ELECTRIC PLANTS
1932 RECORDS
UNITED STATES
LEGEND
X PURCHASE POWER
● GENERATED POWER
NORTH DAKOTA
SOUTH DAKOTA
WYOMING
COLORADO
NEW MEXICO
ARIZONA
NEVADA
OREGON
GULF OF MEXICO
PACIFIC OCEAN
HAWAII
ALASKA

national policy. Hundreds of millions of dollars have been expended under that policy. The development of railroad, pipe line, highway, and aeroplane transportation has changed the situation in many respects. The committee is of the judgment that existing major waterway projects, such as those on the main stem of the Mississippi, be continued; but that further extension of the improvement of inland waterways, except of course on such great arteries as the Great Lakes-St. Lawrence system, be held in abeyance pending further investigations.

These investigations should be of three kinds: (*a*) Studies of the actual past service and cost experience of Government and private transportation agencies such as those now operating on the Mississippi and Ohio Rivers; (*b*) Cost studies of an order never yet undertaken, involving essentially emphasis on basic energy costs (labor and materials) and less emphasis on capital costs, which within the perspective of a 50-year program are likely to be much less than in the past; (*c*) and studies of economic trends and probably regional developments, in the light particularly of a probable new distribution of land uses and of industries.

It is believed that water has its place in a comprehensive transportation system, as have the other facilities which have been developed. But it is believed also that we have not adequate information concerning the functional place of each in such a system. The functional suitability of each type should be determined, and development of each as part of a comprehensive transportation system should then proceed accordingly. Present investment should not dominate determination of a comprehensive policy, as many years need not elapse before present investments from the public point of view have been completely liquidated.

In the meantime the committee suggests that there be established a commission charged with regulation and supervision of ocean-borne, harbor, and inland water transportation, comparable to the Interstate Commerce Commission. Such a commission could make not only the studies suggested above, but also more detailed studies to produce data basic for determination of policy relating to benefits, contributions and fees for use of special facilities. Eventually all transportation commissions might be consolidated into a single body.

(*d*) *Power:* Power, one of the most important needs of man, is normally an income-producing factor and is conceived by the committee as a coordinating agency of great significance. The combining of power generating facilities, where technically practicable, with any type of dam (whether built for flood control, low water control, navigation or recreational purposes) may make economically feasible many a project which otherwise might not be so. In multiple purpose dams, especially where made parts of an interconnected system, there is possible an extension of the generation and use of electricity both for industry and domestic use heretofore unknown. The committee visions an expansion of rural electrification to an extent not as yet generally believed possible. Extension of rural electrification would raise agricultural operations to a more productive plane, and would recreate agricultural life and culture. The indirect effects would be a powerful stimulant for industry, for it would create a huge demand for durable producer goods and durable consumer goods. The better hydro sites—i. e., better, from the point of view of existing markets—have already been developed. But there still exist sites which rank among the best technically, in localities where one or another type of water control is an exigent problem. To the extent that is rational and practicable, provision for future generation of electric power should be made whenever any such projects are undertaken, even though generating operations are deferred. The time may come, the committee believes, when high-power transmission may be regulated as a common carrier, in which case it may be possible in some instances for generating stations now without local markets to be connected in, to sell their power to whatever distant markets are available. It is conceivable that under such circumstances power generated in connection with public-stream control works may be able to liquidate operating and carrying charges, and in some instances amortize the investment.

One phase of public policy in respect to power should be the retention by the Federal and State Governments of the ownership of all power sites on public lands.

IV. LINES OF ACTION—REPRESENTATIVE REGIONAL PROBLEMS

In time, the limited water resources of the Nation doubtless will be utilized fully, and even now the further development of large areas, in the humid East as well as the arid West, depends in considerable part on the extent to which water may be conserved by storage. Less certain but more important than the greater and ultimately complete use of water resources throughout the country is their equitable and efficient use, for the greatest good of the greatest number of people. In seeking that goal it is essential in most cases that a given drainage area be studied as a unit; not otherwise can its water resources be developed in an orderly, balanced manner, conducive in greatest measure to the general welfare of the whole area. The water problems of any large drainage basin differ from those of other basins. The more urgent problems in the basins of the far West result from the demand for water to be used in irrigation; the future of the alluvial valley of the Mississippi hinges on the flood problem; questions of public water supply, of stream pollution, and of storage for multiple use are of major concern in the Northeast. Even though contiguous river basins may have the same pivotal problem, as in the far West, the dominant aspects of that problem (technical, economic, legal, as the case may be) vary more or less from one basin to another. Obviously, no common plan for the control and use of water in different basins will suffice.

To recommend for any basin an inclusive water plan without an exhaustive study of adequate data bearing on all phases of the many problems involved would be most illogical, would invite and deserve severe criticism, would involve economic waste, and might preclude the formulation of a well-balanced plan later. Unfortunately, fundamental data, the consideration of which is a prerequisite to effective planning of an inclusive character, still are lacking in greater or less degree on both the surface and underground waters of most drainage areas throughout the country.

Representative problems of various basins or groups of basins are noted briefly in the following pages.

1. The North Atlantic Basins

Further utilization of waters in the densely populated north Atlantic seaboard is dependent in large measure on the coordinated development of storage for river regulation. The wide range of administrative and technical problems that are involved in multiple uses of water in this region is illustrated best by the Connecticut and Delaware Basins.

(*a*) *The Connecticut Basin:* The lower reaches of the Connecticut River are crowded with manufacturing plants which, together with the accompanying urban areas, have utilized most of the available water power, have made heavy drafts on the stream waters for industrial purposes, and have polluted these waters to such an extent that the river is used for recreation but little and the operation of certain industries is inconvenienced seriously. The congested urban areas are subject to occasional damaging floods. Cooperative efforts to abate objectionable practices in the disposal of obnoxious waste have been initiated recently, but there remains an abundant opportunity to increase the output of prime power, reduce low-water pollution, and minimize or eliminate floods by provision of additional storage facilities on the tributaries and headwaters. The chief factor standing in the way of this needed development has been the lack of an appropriate agency to make surveys and studies which would recognize all interests, and of an appropriate authority to estimate the costs of feasible works and allocate them among the four States, the scores of municipalities, and the hundreds of business enterprises that would benefit from regulation.

(*b*) *The Delaware Basin:* Regulation of the main stem of the Delaware River is completely lacking. Sites suitable for the generation of an estimated 165,000 kilowatts of prime power remain undeveloped. Potential water supplies for New York, Philadelphia, and other metropolitan areas are not utilized, and it is only recently that litigation has established the right of New York to 440,000,000 gallons daily from the headwaters. The Delaware below Port Jervis is badly contaminated, and at times of low flow the supplies of water derived from the lower river and the bay are further endangered by the intrusion of salt water from the ocean. An old compact between New Jersey and Pennsylvania to maintain a clear way for navigation has prevented the construction of power dams, as have the conflicting interests of New Jersey and New York, the former in power and the latter in water supply. The possibility of linking a power-generating program with mouth-of-mine units in Pennsylvania and hydro units in New York has not been explored fully. It seems

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RED RIVER DRAINAGE
GREAT LAKES & ST LAWRENCE RIVER DRAINAGE
NORTH ATLANTIC DRAINAGE
MISSOURI RIVER DRAINAGE
UPPER MISSISSIPPI RIVER DRAINAGE
SOUTH PACIFIC DRAINAGE
GREAT BASIN DRAINAGE
COLORADO RIVER DRAINAGE
SOUTHWEST MISSISSIPPI DRAINAGE
OHIO RIVER DRAINAGE
ALLUVIAL MISSISSIPPI RIVER DRAINAGE
EASTERN GULF & SOUTH ATLANTIC DRAINAGE
WESTERN GULF DRAINAGE
NATIONAL RESOURCES BOARD
WATER RESOURCES SECTION
LOCATION OF
PRINCIPAL DRAINAGE REGIONS
OF THE
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clear, however, that improvement in the use of the Delaware waters will depend on cooperative action involving all three States and the Federal Government.

(*c*) *Other Drainage Areas:* The same concern of urban populations with the regulation of streams is characteristic of the other drainage basins between the Potomac and the Canadian border. Conditions on the Merrimac resemble those on the Connecticut, which, indeed, may be considered as typical of most New England drainages. In general, most of the larger cities have made adequate provision for water supplies, but waste disposal continues to provoke trouble, especially in the lower reaches of the rivers. Alleviation of flood damages depends chiefly on the feasibility of constructing multiple-purpose reservoirs designed primarily for the generation of electric power. The disposition of certain waterways, such as the New York State Barge Canal, and the proposals for the construction of remaining links in the intracoastal waterway require examination in the light of such related water problems as recreation, power, and flood control.

Notwithstanding the patent desirability of comprehensive stream regulation in most of the North Atlantic drainage areas, the Hudson River Basin and a few minor basins are the only ones having either the plans or the administrative machinery requisite to achieving such regulation. Progress by the Hudson River Regulating District has been possible chiefly because the basin lies almost wholly within one State.

2. The South Atlantic and Eastern Gulf Basin

Three areas, each of which has a distinctive combination of water problems, may be recognized in the South Atlantic and Eastern Gulf region. Throughout the region there are now few conditions of water use and control that urgently require remedial measures, but the general failure to make provision for cooperative regulation and development foretells a time when, unless present practices are modified, many problems will become acute.

(*a*) *Piedmont Drainages:* Between the Potomac River and central Alabama most of the streams which rise in the Appalachian Mountains or Piedmont Plateau and flow eastward across the coastal plain are subject to conflicting utilization. On the Piedmont, where much potential water power is located and where ground waters are far from abundant, stream regulation has been developed chiefly for power generation and for water supply and sewage disposal. Birmingham, in the Black Warrior and Cahaba drainages, and Atlanta, in the Appalachicola drainage, are examples of cities where there is existing or probable future conflict between uses of water for power and for domestic supply. The water-power developments of the Piedmont also have been located and designed without regard to possible power generation, flood prevention, and low-water control on the coastal plain. In some cases the most feasible regulation in the Piedmont depends on the results of an exploration of ground-water supplies for use by towns and cities of the plain.

The difficulty of reaching interstate agreements has been a strong factor in retarding the making of plans for whole rivers or river systems rather than for parts of them. An illustration is afforded by the Potomac system, in whose basin the effective control of stream pollution is of grave concern to municipalities and industries in four States and the District of Columbia. The deep-rooted conflict between the agricultural coastal plain and the manufactural Piedmont has militated against recognition of common interests in stream control throughout the entire area.

(*b*) *Peninsular Florida.* The problems of this subdivision are peculiar to the coastal plain. Surface streams are relatively unimportant, and the determination of ground-water distribution in the underlying porous limestone is a matter of moment to the cities and to rural areas where irrigation is practiced. When the available resources have been ascertained and mapped, regulation for the prevention of undue depletion and of pollution by waste disposal will be in order. Much speculative land drainage appears to have been premature and ill-advised in Florida (as also farther north), and the necessity of great care in promoting further drainage enterprises is indicated. Proposals for the extension of coastal waterway facilities also should be subjected to detailed examination from the standpoint of economic feasibility.

(*c*) *Western Drainages:* The westernmost streams of the region, the Pearl, Pascagoula, and Tombigbee Rivers, in Mississippi, drain almost wholly from the Coastal Plain, and therefore are not suited to the production of power. Flood control and low-water control for disposal of industrial waste are the chief problems, but in most places they do not seem at present to warrant regulatory works.

In this area, as in the other subdivisions of the region, the individualistic approach to water problems which has prevailed in the past will need to be replaced by a coordinated approach representing all interests concerned, if an effective use and control of water is to be realized.

3. The Great Lakes—St. Lawrence Basin

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(*a*) *Navigation:* The Great Lakes-St. Lawrence system constitutes one of the world's major waterways, and its further extensive improvement is the subject of a treaty between the United States and Canada. The existing improvements in the interconnections between the Lakes, including the St. Marys, St. Clair, and the Detroit Rivers and the Welland Ship Canal between Lake Erie and Lake Ontario, have opened the entire waterway from Duluth and Chicago to Ogdensburg, N. Y., to a minimum depth of 20 feet. The natural barriers to navigation between the Lakes and tide water at Montreal are now bypassed with 49 miles of Canadian canals, with 22 locks, in which the controlling depth is 14 feet. The plans for continuing the improvement of this waterway system would provide navigation with a minimum depth of 27 feet from Duluth and Chicago to open ocean by: (1) Deepening the Great Lakes interconnecting channels by dredging and the construction of an additional lock in the St. Marys River; (2) the construction of two dams in the international section of the St. Lawrence River, with associated canals, locks, and channel enlargements; (3) the completion of a canal with locks to bypass the power dam recently completed in the Canadian Soulanges Rapids section; and (4) the construction of a new 9-mile canal with locks from Lachine to Montreal.

If changes are made as contemplated in the dimensions of the channels, with a view to accommodating vessels of greater draft they should be accompanied by further development and coordination of port facilities at the major ports. In such districts as the Illinois-Indiana area on Lake Michigan, the unsystematic arrangement of terminals is recognized by local interests. Some impetus from Federal agencies will probably be required before adequate corrective measures are applied.

Problems associated with the Illinois-Mississippi waterway and the New York Barge Canal are involved in any broad design of the best transportation system for the entire drainage basin. Other minor waterways such as the Fox River require consideration.

(*b*) *Power Development:* Plans for continuing the improvements for navigation in the basin provide also for a major power development utilizing the full discharge of the Great Lakes through the international section of the St. Lawrence River. The plans call for an installation of 1,100,000 horsepower on the United States side of the boundary. A unique problem of regulation relates to the preservation of the scenic beauty of Niagara Falls, which is closely related to power development. The headward erosion of the crest of the falls threatens to concentrate the water in a narrow crevice and to correspondingly injure the magnificent spectacle they present. Remedial works have been proposed which would retard the erosion and distribute the flow of water so as to permit further diversions for power use without injury to the scenic effects. Storage reservoirs are proposed for regulating the flows of New York streams tributary to the Great Lakes-St. Lawrence system. If fully carried out, such storage regulation would make possible an increase from 500,000 horsepower to 1,000,000 horsepower 60 percent of the time in the hydroelectric power available from these streams.

(*c*) *Water Supply and Sanitation:* All the important urban areas along the shores of the Lakes rely on the Lakes for water supply and for waste disposal. The diversion of water to dilute Chicago sewage, long a matter of interstate and international controversy, has been the subject of a decision by the Supreme Court of the United States, but the pollution of the Chicago water supply by sewage from Indiana cities, of Toledo water supply by Detroit sewage, and of that of Niagara Falls by Buffalo sewage is still serious. Cooperative action aimed at correction of these conditions seems plainly needed.

(*d*) *Problems of Small Tributary Basins:* The use and control of waters in those areas of New York and Vermont which drain into the Great Lakes-St. Lawrence Basin are associated closely with the St. Lawrence project. Floods are a hazard in the relatively densely populated valleys of many of these small Appalachian and Adirondack basins, but reservoirs for flood control are warranted generally only in connection with the generation of power. Since the peak flows of the tributaries are not coincident in time with high stages of the St. Lawrence River, the coordinated development of the two may be desirable. In the small drainage areas west of New York, flood control is the chief water problem. On certain reaches of such lowland streams as the Saginaw and Grand Rivers in Michigan, the Wolf in Wisconsin, and the St. Marys in Indiana, floods are a hazard that may be eliminated by channel works. Surface water supplies are fairly abundant throughout the region and ground waters are plentiful but hard.

Most of the basic facts relative to the major problem of the Great Lakes-St. Lawrence Basin including the problems of various compensatory works to maintain the lake levels at their natural heights or regulatory works to control fluctuations in levels and discharges, are now in hand, and a decision concerning the initation of an orderly program of development need be delayed no longer.

4. The Upper Mississippi and Red River of the North Region

There appear to be no outstanding and pivotal water problems in the Upper Mississippi and Red River region. Rather there are several minor problems, no one of them dramatic in itself, which taken together reflect conditions that have played a significant role in

the maintenance of a relatively low economic status in various parts of the region. Chief among these problems are those of water supply, stream pollution, drainage, and flood control.

(*a*) *The Upper Mississippi—Water Supply and Stream Pollution:* In the densely populated southern two-thirds of the region, waste from manufacturing plants and urban areas is a common menace to public water supplies. Effective reduction of pollution centers about the regulation of a single large stream in certain areas, as in the Illinois Basin, and involves many small streams in other areas, as in southern Illinois, where public health has been affected seriously. Consolidation of the water-supply and sewage-treatment works of neighboring municipalities and compulsory treatment of industrial waste offer relief in the congested metropolitan areas. A more perplexing question of control is found in rural areas where decentralized manufacturing plants pollute the sources of water for farmsteads and villages, and injure or destroy fish life.

(*b*) *The Upper Mississippi—Drainage:* The drainage of peat bogs in northern Minnesota and central Wisconsin induced the clearing and cultivating of lands of low fertility and paved the way for the subsequent failure of agricultural occupation and a bankruptcy of settlers, drainage districts, and counties. The substitution of a program of orderly retrenchment for one of speculative expansion is plainly indicated. The maintenance of some drainage facilities in these areas may, however, be feasible for part-time farming and for forest and game management. In some areas where tile drainage has been successful and the outlets and conduits are silting up, repairs and replacements are urgently needed.

(*c*) *The Upper Mississippi—Flood Control:* No major floods occur in the region, or originate there, but some of the agricultural bottom lands suffer more or less from occasional inundation. Indeed, unwise extension of levees and drainage structures has so aggravated the flood situation along several streams, notably the Illinois River, that abandonment of some of the crop land there for use as floodways, game refuges, and reservoirs seems desirable. As in the case of drainage, wise modification of existing water-control works may deserve more attention than the construction of new works.

Few of the conditions that have been noted warrant independent regulatory treatment; they bear too close a relation to other water and land problems. The proper solution lies in an inclusive inventory of existing resources and the development of appropriate instruments of comprehensive planning, such as land-use zoning, which would give due place to the control and use of water in the improvement of the economy of the region as a whole.

(*d*) *The Red River of the North:* The regulation of low-water flow for purposes of water supply and waste disposal is a matter of prime concern in the drainage area of the Red River of the North. All towns on the main stem of the river and many on the tributaries suffer from semiannual shortages of water which have become especially severe during the recent succession of dry years. The main stem is little more than an open sewer which receives much raw waste, is unfit for recreation, fails entirely over short periods, and frequently is so low that the operation of the few sewage-treatment plants is curtailed. Groundwater tables have receded, and some artesian aquifers have been depleted. At an early period floods were a menace in the nearly level lacustrine plain traversed by the river, as well as in the valleys of the tributaries, and in both areas any extension of drainage works that may prove desirable is contingent on flood control. Numerous small lakes in the rolling moraines of the parts of the drainage in Minnesota appear to be susceptible to regulation for water storage, with corollary benefits to recreation.

Several independent multiple-purpose projects have been proposed. Negotiations for a compact among North Dakota, South Dakota, and Minnesota were begun in 1925, and a tri-State drainage district was under discussion as early as 1900. Little progress in interstate cooperation has been made, however, because State agencies have lacked the authority and requisite staff to collect basic data and formulate plans. Local interests are now acutely conscious of the desirability of a comprehensive program of water conservation, but they need technical aid in administrative coordination.

5. The Missouri Basin

The vast and culturally diversified expanse of the Missouri Basin may be divided into six areas having distinct combinations of water problems.

(*a*) *The Ozark Highland:* The rugged topography and stony and gravelly soils of the Ozark Highland in southern Missouri and northern Arkansas furnish the basis for a relatively sparse population and, in most districts, a notably unproductive agriculture. Amelioration of floods on both the lower Missouri and the lower Mississippi, generation of power, and development of recreational centers, may all be attained by reservoir construction. In view of the widespread erosion, submarginal agriculture, and unsatisfactory condition of most of the forests in the Highland, and in view also of the growing demand for power and recreation in the nearby urban areas of the lowlands, the promotion of highland culture may be linked advantageously to the promotion of water storage.

(*b*) *The Eastern Lowlands:* Cooperative action by groups of cities and towns is an essential factor in the solution of the chief water problems in the comparatively stable and urbanized lowlands in the eastern third of the basin. Flood protection is inadequate on several streams. Cities along the Kansas River, and the Kansas City metropolitan area in particular, are menaced by disastrous floods the control of which would require a coordination of local interests that has been lacking in the past. Water supply on the Osage River and navigation on the Missouri River are other examples of problems of concern to various urban communities.

(*c*) *The Central Plains:* Inadequate supplies of soil moisture for crops and pastures, and inadequate quantities of surface water and of ground water recoverable from existing wells for people and stock, are fundamental aspects of the present economic problems of the wide zone of semiarid plains land stretching north and south across the Missouri Basin. Dry farming is hazardous, irrigation farming is restricted and in many localities unsuccessful, and locally soil erosion is serious. The recent drought has emphasized the fact that widespread changes in farm practice and in land use should be made, and that Federal participation in sound projects for the use and control of water should be an integral part of such an agricultural and land-use program. The specific types of projects involved include the construction of reservoirs for water supply, irrigation, power, and flood control, and the deepening and drilling of thousands of wells in the light of ground-water surveys.

(*d*) *The Black Hills Uplift:* The Black Hills stand out in the semiarid plains as a relatively humid, forested island, rich in minerals. Their scenic attractions make them a recreational center of great potential value for people from neighboring States. The possibility of producing cheap mouth-of-mine power at nearby lignite deposits may afford a basis for further manufactural and agricultural development, and this, in turn, may so increase the need for water for domestic, industrial, and irrigation purposes as to raise new problems of its use and control.

(*e*) *The West Platte Basin:* Regulation of stream flow to attain the maximum use of water for irrigation and municipal purposes is the chief problem in the Platte Basin west of Grand Island. Irrigation is more successful in this drainage area than in any other part of the Missouri Basin, but in some localities the cropped acreage has been expanded unduly during wet years with resultant shortages of water during dry years. The growth of certain cities on the Colorado piedmont is also threatened by lack of water. Additional supplies may be secured in part by transmountain diversion from the Colorado Basin and in part by the construction of expensive works for impounding flood flows. These methods involve the rights of various cities, irrigation districts, and States, and have as their chief obstacle the legal compromise of conflicting interests. The disposition of South Platte waters is fixed by interstate compact, and the Colorado compact is in course of settlement. Allocation of the waters of the North Platte is a subject of litigation. The revision of old compacts and the making of new ones seem certain to recur in response to changing conditions.

(*f*) *The Northern Mountain and Plains Border:* The water problems of the Rocky Mountain slopes north of the West Platte area are in many respects similar to those of the latter, though not as urgent or as clearly defined. Conflicting uses of water have reached a serious stage on only a few streams, such as the Tongue River. A more important matter at present is the control of grazing on approximately 14,000,000 acres of unappropriated public land; appropriate control would reduce erosion and thus influence silting in existing and potential reservoirs and in the Missouri River.

6. The Ohio Basin

The Ohio Basin has a dense population, supports a diversified industrial structure, contains a variety of land forms, and usually receives adequate to copious precipitation. This basin, therefore, is confronted with all the water problems characteristic of a complex and highly developed humid region. Attention centers on the control of excess run-off during flood periods and on the most effective utilization of valuable water resources. Highlights of some of the conspicuous water problems of the basin are given in the following paragraphs.

(*a*) *Flood Control:* Throughout the Ohio Valley flood control is a matter of much significance. Almost all of the more important cities and towns are located adjacent to the Ohio River and its major tributaries, while the rich bottom lands along these streams are used for agriculture. Any serious flooding of such intensively occupied areas results, of course, in heavy losses.

Natural conditions favor frequent floods. The size and location of the basin are such that heavy rains occasionally fall simultaneously over a large part of it. At such times the river system is charged with more water than can drain off promptly through the main stem. Spring thaws also may produce large volumes of water in a short time. Regulation of these floods by the construction of large storage reservoirs on the main streams is virtually precluded by the high value of the land along their banks. Reservoirs on the tributaries, combined with local levee systems, appear to afford in most cases the best solution of local flood-control problems.

The Ohio ranks as the greatest flood-producing tributary of the Mississippi. For this reason, successful high-water control in the Ohio Basin would help to reduce flood crests on the lower Mississippi.

(*b*) *Navigation:* More commerce is carried by the Ohio River and its tributaries than by any other river system in the United States. This condition results largely from the fact that the Ohio itself parallels a main direction of traffic movement and that several of its navigable tributaries reach important coal fields. Some $240,000,000 have been spent by the Federal Government for improvements in behalf of navigation on the system. Powerful local opinion favors further development of this waterway system and its continued maintenance entirely at Federal expense. The justification of such a policy is challenged in other quarters, especially since most of the traffic is moved by private carriers. Beyond doubt, navigation on the Ohio presents an intricate economic and financial problem in addition to the engineering problems normally to be expected.

(*c*) *Water Supply and Stream Pollution:* All the major streams in the Ohio Basin serve both as sources of water for domestic and industrial use and as carriers of sewage and other wastes. At normal stages, the Ohio and its principal tributaries have sufficient water for present purposes, but during low stages the decreased and polluted supplies may cause outbreaks of intestinal disturbances. This situation is being corrected gradually by the installation of water-purification facilities, by the construction of sewage-treatment plants, and by the use of pollution-control works at coke ovens and other industrial plants.

(*d*) *Water Power:* Approximately 200 sites for hydroelectric plants at which an estimated 8,700,000 kilowatts could be developed exist in the Ohio Basin. At present, however, only about 15 percent of the electricity generated for public use in the region is produced by water power. This comparatively small production of hydroelectricity depends largely on two factors: (1) Most of the streams require expensive reservoirs to provide a dependable supply of water, and (2) cheap coal is available in abundance to operate steam plants. Further development of water power should be based on careful surveys of local, regional, and interregional conditions.

(*e*) *Problems of Sub-basins:* A number of the sub-basins of the Ohio region present complex problems of readjustment in economic structure as well as water use. Some of the highly industrialized sub-basins at the east are troubled with stranded populations and slack employment in mining areas, and with much agricultural occupation which is distinctly unprofitable. A study of these economic questions is already under way in the upper Monongahela Valley, and a combination of such remedial measures as land purchase and manufactural decentralization with measures involving the use and control of water seems desirable. The densely populated Kanawha Basin, including the Greenbrier and New River drainage areas, provides a good example of the opportunities for integrated development to be found in the Appalachian region. Several large reservoirs for the alleviation of Ohio River floods appear feasible, and may have corollary utility for control of Kanawha River floods and the generation of power. The demand for further improvement of the river for navigation, the move to coordinate hydroelectric units with steam units utilizing the abundant supplies of coal, the tendency toward decentralization of manufacturing, the apparent multiple utility of proposed reservoirs, and the need for correlation of watershed protection with a land-use program, are all important factors which require investigation from the standpoint of their possible contribution to the prosperity of the basin as a whole. Interregional possibilities, involving especially relations between the Kanawha and James Basins, should be an important phase of the investigation.

7. The Southwest Mississippi Basins

The southwestern basins of the Mississippi drainage area include the Red, Arkansas, White, and Ouachita River systems. With an average annual precipitation that ranges from 11 inches in eastern Colorado to more than 52 inches in Louisiana, the district has water problems that are fairly well defined and regionalized.

(*a*) *Irrigation:* In the western part of the area a high irrigation culture has outgrown the available water supply from natural stream flow. Conservation by storage is necessary, and diversions from the western slopes of the Rockies to the headwaters of the Arkansas are deemed essential to future growth. In the lower Arkansas Basin and immediately south of the lower Red River Basin shortages of water for rice lands are being felt. The subsurface sources in Arkansas from which the present supply is being pumped are failing, and pumpage costs are mounting toward prohibitive limits. There accordingly is demand for the diversion of surface waters to the rice fields.

(*b*) *Flood Control:* The major flood problems of the district are found east of the ninety-ninth meridian. Levees to protect more than 2,000,000 acres have been constructed, but, as usual with unplanned, uncoordinated levee development, protection has been inadequate and flood losses continue to be high. A large number of widely scattered, apparently feasible levee projects have been proposed for the protection of rural and urban lands. It is to be noted, however, that lands and municipalities on long stretches of the Arkansas, North Canadian, Grand Neosho, Salt Fork, White,

and Red Rivers could be protected, at least partly, through the construction of six proposed reservoirs. The degree of such protection and its economic justification or lack of justification have not been determined in each case. Until such evaluations are made, it perhaps is undesirable to consider any levee projects except those that would not be influenced materially by any of the reservoir projects. The flood-control problem is complicated by the fact that two of the reservoir projects in question, Denison and Table Rock, are designed primarily as power projects, with associated flood-control features. These features, accordingly, should also be evaluated in the light of the power situation.

(*c*) *Power:* At present hydroelectric development is small in the region, due in part to natural conditions of topography and stream flow, and in larger measure to the competition of low-cost thermoelectric plants utilizing the natural gas, oil, and cheap coals of the region. Moreover, no new markets of magnitude for power are definitely in sight under existing technical and cultural conditions.

(*d*) *Municipal Water Supply:* Owing to the intermittent nature of the flow of the stream in these basins, problems of deficiency in domestic water supply are becoming increasingly acute. Several storage reservoirs have been proposed for the improvement of these conditions. The Fort Reno and Council Grove reservoirs are of this character.

(*e*) *Navigation:* While there is some agitation for the extension of existing navigation projects, there appears to be little or no justification for such extension. Indeed, existing projects on the Red, Arkansas, and White Rivers do not seem to be justified economically.

8. The Lower Mississippi Region

The future economic development of the poorly drained, alluvial lands of the lower Mississippi drainage depends in large measure on flood protection along the tributary streams and the perfection of adopted plans for the control of Mississippi floods.

(*a*) *Flooding From Tributaries:* Upon completion of the adopted plan for control of the lower Mississippi River about two-thirds of the alluvial valley will be protected from Mississippi floods, but only about half of it will be protected from all floods. Much land that will be protected fully will still require drainage before being suitable for cropping. In all cleared areas, agriculture is the dominant activity of the alluvial valley and is characterized by one-crop cotton or sugar farming, by the share-cropper system of management, and by a relatively low gross income per farm operator. Notwithstanding the high productive capacity of the fertile alluvial soils, the standard of living which prevails in the rural areas is very low.

In the alluvial bottoms of the St. Francis, White, Ouachita, and Yazoo Basins, at least 7,000 square miles are now subject at times to inundation. Because of the flood hazard, much of the bottom land is not cleared, most of the drainage districts are unsuccessful, and the development of small, independent farm units is made difficult. Migration of population downhill from the adjacent badly eroded uplands has taken place at a moderate rate in response to the higher incomes obtainable in the alluvial valley, even under the "cropper" system. Some drained and protected lands remain uncultivated, but the principal opportunity for the extension of agriculture lies in the flooded areas, where poorly coordinated levee works have only intensified the flood problem, but where complete protection apparently may be obtained by reservoirs. The magnitude of a program for comprehensive reservoir control requires the leadership of the Federal Government. The chief question involved is whether or not Federal participation is warranted in flood-control projects in which no provision is made for land settlement and development designed to insure a standard of living notably higher than now prevails. In a broader sense, the question is whether the mode of life now dominant should be perpetuated and extended. If the answer be in the negative, then flood-control projects afford a powerful instrument for effecting a change.

(*b*) *Mississippi Floods:* Following the failure of the levee system during the great flood of 1927, the Federal Government adopted in 1928 a plan (1) for levees that normally will confine the Mississippi River to its main channel and backwater areas, and (2) for flood ways, aggregating some 4,000 square miles in extent, that will carry part of the water of high floods expected to occur on an average of once in 13 years. This adopted plan has met criticism on three major scores. (1) The inundation of the flood-way lands by the breaking of "fuse-plug" levees may cause serious damage to agriculture, may necessitate upon occasion expensive relief activities, and may cost the United States heavy payment for damages. Accordingly, purchase of the flood-way lands, by the Government and/or construction of concrete spillways that would reduce the extent and duration of their submergence have been proposed. (2) The building of guide levees along the flood ways will interrupt the natural drainage channels in most places, but no provision for the readjustment of these channels was made in the adopted plan. The desirability or nondesirability of Federal participation in such readjustment is a moot question. (3) The levees as constructed will provide a freeboard of 1 foot over the estimated level of the maximum possible flood. It is

contended in many quarters that an additional margin of 2 feet is desirable, and that this can be obtained only by constructing reservoirs on tributaries of the Mississippi.

Appropriate modifications of existing plans in respect to the foregoing problems (1) would facilitate the productive utilization of the flood-way lands, (2) would improve drainage conditions on adjacent lands, and (3) would promote the safety of most of the alluvial valley.

9. The Western Gulf Basins

These basins are the drainage areas of the Rio Grande and the rivers that empty into the Gulf of Mexico between the Rio Grande and the Mississippi. The development of a comprehensive plan for the Rio Grande Basin as a whole, looking to the best development and use of its waters in the interest of all concerned, appears to be an indispensable prerequisite for a permanently satisfactory solution of urgent interstate and international problems. The Brazos Basin, in contrast, affords a promising and immediate opportunity for cooperative planning looking to the solution of a distinctive group of intrastate problems.

(*a*) *The Rio Grande:* Conflicts have arisen over the use of the waters of the upper Rio Grande system that involve Colorado, New Mexico, and Texas, while New Mexico and Texas disagree over the division of the waters of the Pecos, the largest tributary of the Rio Grande. The Rio Grande Compact of 1929, which provided for temporary maintenance of the status quo of waters in these States, expires July 1, 1935.

In the lower valley, the interests of the United States and Mexico in the waters of the Rio Grande are in conflict. Most of the irrigated land along the lower river is in the United States, whereas most of the water in the lower river channel comes from tributaries in Mexico. About three-fourths of this water is now unused, but reservoirs are under construction in Mexico to store most of it for the irrigation of additional lands there, a program that would result in a shortage of water for the lands now irrigated in the United States with water from the lower river. An agreement that will recognize and perpetuate existing uses in the United States is most desirable.

(*b*) *The Brazos*: The Brazos Basin, practically all of which is in Texas, is approximately equal in area to the State of Pennsylvania. There is need for flood protection along the lower river, more water than is available in dry summers is needed in parts of the valley for water supply and for irrigation, and there are possibilities for hydroelectric development in various places. To meet these needs and possibilities, proposals have been made to control and conserve the run-off from the upper drainage area by storage in several large reservoirs. No detailed studies have been made and no definite plan has been worked out, but a recent State law has created the Brazos River Conservation and Reclamation District with a view to the formulation and execution of "a plan for the coordination of improvements deemed adequate to serve said watershed as a whole." The desirability of such a plan is apparent, in order that further development may proceed in an orderly and balanced manner. Federal cooperation is desired by local interests and may be warranted to promote the general welfare.

10. The Colorado Basin

Though the part of the Colorado Basin in the United States has an area of 242,000 square miles, its inhabitants number only 830,000. Lack of water, more than anything else, has restricted its growth in population. Lack of water, more than anything else, likewise limits its potentialities. At present, the question of *where* the available and potential supplies of unused water shall be utilized is more urgent than the question of *how* they shall be utilized. Allocations between the American and Mexican portions of the basin, between the upper and lower parts of the basin in the United States, between the four States of the upper basin, and between the basin and areas beyond its limits, all are involved.

(*a*) *International Relationships*: After crossing the international boundary, the Colorado River flows for about 100 miles through Mexican territory before emptying into the Gulf of California. Most of the American States of the basin hold that since the entire flow of the river originates in the United States, the latter is under no necessity of considering the claims of Mexico to part of it after the completion of the All-American Canal, and they stoutly oppose releasing to her more than 750,000 acre-feet. Mexico, on the other hand, claims 3,600,000 acre-feet or more, chiefly on the basis of an arrangement of 1904 under which she is entitled to half the capacity of the International Canal (running for 50 miles or more through Mexican territory and heretofore serving the Imperial Valley with water diverted from the Colorado), an arrangement under which, moreover, a large area has been irrigated in Mexico. If the United States has control of the water supply of the Colorado, Mexico has similar control of that of the lower Rio Grande, where, as already stated, the interests of the two countries likewise conflict. It is possible that the problems of allocating the waters of the two rivers must be considered together in order to reach solutions acceptable to both nations.

(*b*) *Intra-basin Regional Relationships within the United States:* The total volume of water that can be diverted from the Colorado System for irrigation in the United States is insufficient to serve all the lands in that part of the basin that would be suitable for cultivation were water available. For various reasons, the

agricultural utility of water is in general far greater in the lowermost part of the basin than it is in and near the mountainous fringes of the upper basin where most of the water supply originates. Application of the fundamental principle that water for irrigation should be used, if practicable, where its utility will be greatest would require reconsideration in the national interest of the division of water between the upper and lower parts of the basin that the Colorado Compact was designed to accomplish.

(*c*) *Interstate Relationships within the Basin:* The Colorado Compact, which Arizona has declined to ratify, provides merely for a division of the waters of the Colorado System between the Upper Basin and the Lower Basin. The four States of the Upper Basin still have to agree among themselves on (1) the responsibility of each in permitting the required volume of water to flow to the Lower Basin, and (2) the allocation among themselves of their joint apportionment. The problems involved are difficult, quite apart from the consideration set forth in the preceding paragraph.

(*d*) *Relationships of Transmountain Diversion:* It is estimated that some 8,700,000 acre-feet are involved in diversions of water from the basin that have been made or proposed. This amount is about half the average annual discharge of the Colorado River, and its very magnitude raises important questions.

(*e*) *Principles of Action:* The water resources of the Colorado Basin have been studied heretofore largely in terms of State and municipal interests. They should be studied in systematic detail in terms of the basin as a whole, with due regard to the various interests and relationships involved and in the light of all relevant economic and cultural conditions.

11. The South Pacific and Great Basin District

This district includes virtually all of California, most of Nevada, the western half of Utah, and part of southern Oregon. Many of its major water problems, particularly those of California, have been solved through projects completed in recent years, projects now under construction, or projects to be undertaken in the immediate future. Further investigations may bring to light regional water problems not as yet recognized. A few regional projects of varying magnitude are noted below as indicative of the range of problems involved.

(*a*) *The Great Salt Lake Basin:* The major water plans so far developed for this area, which by nature lends itself admirably to segregation as an administrative planning unit, are now being carried out by the United States Bureau of Reclamation. Future planning in the area doubtless will concern itself in part with the following: (1) The search for additional subsurface water supplies to be used for livestock and for the irrigation of lowlands, so that higher irrigated lands may have an adequate supply of surface water. (2) The regulation of mountain streams in the West Desert, through equalizing reservoirs, diversion dams, and other means, a procedure which, it is estimated, may increase the effectiveness of their utilization by as much as 500 percent. (3) Control of grazing, which has promoted the denudation of entire drainage areas and thus has intensified greatly the problems of water conservation. (4) The correction of practices whereby lowlands have first right to surface waters, and in many cases become water-logged, while higher lands have insufficient supplies. (5) The reorganization of irrigation units into a smaller number of larger systems, capable of a more economical utilization of water resources than now is possible.

(*b*) *The Great Basin:* In Nevada there is great need for locating, if possible, more subsurface water which may be pumped for the benefit of livestock. Few opportunities, if any, seem to exist for new irrigation projects, though the extension of certain existing projects is under consideration.

(*c*) *The Central Valley Plan:* The outstanding project of the district, overshadowing all others, is the Central Valley project of California. This is designed to secure the following major benefits: (1) Regulation of the flow of the Sacramento River by means of the Kennett Reservoir, thus assuring Sacramento irrigation projects adequate supplies of water at all seasons. (2) Provision of an adequate amount of irrigation water for the upper San Joaquin Basin, through the Friant Reservoir. (3) Provision, by pumping surplus water from the Sacramento to the lower San Joaquin Basin, to replace water distributed in the upper San Joaquin Basin from the Friant Reservoir. (4) Restoration of the navigability of the lower Sacramento and San Joaquin Rivers. (5) Amelioration of flood conditions along both rivers. (6) Control of salinity in the Sacramento-San Joaquin Delta and assurance of an adequate supply of fresh water in the delta area for industrial and domestic purposes. (7) Generation of power in a 260,000-kilowatt installation at the Kennett Reservoir.

Though the proposed project is a result of extended study, it has met local opposition. Some of the major views expressed by opponents of the undertaking are the following: (1) The estimates of cost, both capital and annual, are too low. (2) Under the conditions of ultimate development in the Sacramento Basin there will be no surplus water for transfer to the San Joaquin Basin. (3) There is no real need to control the salinity of water in the delta channels. (4) There is no need for additional water supplies for industries in the delta. (5) No market is in sight for the proposed output of

power at rates that will allow this element of the project to be self-liquidating. (6) Irrigation farmers who now have an established right to water from the San Joaquin will not relinquish this right and purchase water transferred from another river. (7) The Central Valley is plentifully supplied with roads and railroads, and expenditures for navigation on two rivers are unwarranted.

12. The North Pacific District

This district includes Washington, that part of Montana west of the Continental Divide, nearly all of Idaho, and all of Oregon except three counties in the south-central part of the State. Almost 90 percent of its area is within the Columbia Basin.

The regional water problems of the district are fairly well defined by natural and cultural conditions. West of the Cascades, where precipitation is comparatively heavy, there are flood problems, and irrigation is less urgent than on the eastern side of the mountains. River navigation, intimately tied to ocean shipping, presents more important problems here than it does farther inland. East of the Cascades, scant precipitation helps to make irrigation highly important. In various localities, both west and east of the mountains, natural conditions are favorable for the development of large amounts of water power.

(*a*) *Power and Irrigation:* The most pressing problem at present in relation to power is the development, through stimulation of industry and otherwise, of markets for the output of projects now under construction, including those at Grand Coulee and Bonneville. The proposal to add greatly to the height of the dam at Grand Coulee is intended not only to increase the output of power, but also, and especially, to promote irrigation and in so doing create a market for power. Much of the power made available by the higher dam could be used, it is contended, in pumping water to irrigate 1,200,000 acres of fertile land above the proposed reservoir and in serving settlers on the land reclaimed. The area of land that could be irrigated is sufficient for some 60,000 farms of 20 acres each, an operating unit there adequate to support, it is maintained, a high standard of rural life. These possibilities should be studied fully, with appropriate regard to the amount of unirrigated land for which water already is available on existing projects. The aggregate area now irrigated in the district is 3,609,000 acres, while the irrigable area on existing projects is 5,211,000 acres.

Over most of the district, water rather than land will be the limiting factor in agricultural expansion, and accordingly there is latitude in the selection of land for reclamation. Some irrigation projects now in existence suffer at times from serious shortages of water, due in part, apparently, to the fact that they were constructed during periods of high rainfall and were designed on the basis of insufficient stream-flow data. This is particularly true in southern Idaho, where there is much need for supplemental water.

(*b*) *Navigation:* There is agitation for further improvement of the navigability of the Columbia River and for expenditures in behalf of the navigation on several of its tributaries. An evaluation of the contemplated projects should be made in coordination with studies and plans relating to the problems of power, irrigation, and agricultural and industrial development already noted.

(*c*) *Other Problems:* During recent years, floods on 24 streams west of the Cascades have caused damages estimated at more than $11,200,000. More thorough studies of the flood problem and greater expenditures for flood control than have been made seem desirable. The pollution of streams and lakes calls for abatement in several localities, including some where there are important spawning grounds for salmon.

SECTION I
V. RECOMMENDATIONS

This report has so far been concerned with principles, policies, and lines of action in their broader aspects. The committee believes, however, that its responsibility would not have been completely met if it failed to make at least a few specific recommendations. It therefore suggests the prompt initiation of certain activities, all of which it considers important and some especially important because of the time factor involved.

1. Surveys, Inventories, and Records of Conditions Fundamental for the Use and Control of Water Resources

In respect to surveys, inventories, and records the committee recommends that, in cooperation, insofar as practicable, with the various States—

(*a*) The topographic mapping of the United States be pushed vigorously to completion;

(*b*) The present system of permanent gaging stations on all rivers concerning which records of flow are important for water resources planning, be extended.

(*c*) Appropriate inventory surveys of water resources of the Nation be undertaken systematically under unified Government auspices;

(*d*) Systematic, uniform land-use surveys of the country be initiated;

(*e*) Studies of the ground waters of the nation be systematically pursued;

(*f*) Study of water supply and sanitation in relation to public health be promoted; and

(*g*) Research in respect to water quality and standards be further promoted.

(*h*) Studies of coastal erosion and methods for its control.

2. Legislative Needs for Use and Control of Water Resources

The committee recommends that provision be made promptly for an exhaustive study, by an appropriate agency, of the Federal and State legislation needed to permit effective cooperation between Federal, State, local, and regional agencies in the conservation of water resources and their more effective utilization in the public interest.

3. Selective Experimentation in Regional Planning

The committee recommends that provision be made promptly for surveys, studies, and experiments in directive and administrative planning in selected unit areas, in terms of all their natural resources (waters, lands, forests, minerals, etc.) and of all their relevant economic and cultural conditions, with a view to promoting all phases of public welfare in such areas. Conditions in the Ozark Highlands, where water may be considered a dominant factor, illustrate the opportunity and need for efforts of such an inclusive character.

4. Planning of Specific Projects

Certain very large projects of water use and control of undoubted national import, such as those relating to the St. Lawrence Waterway, the Tennessee Valley, the Colorado River, the Central Valley of California, and the Columbia River, have been studied intensively over a period of years and some are now definitely planned or are under actual construction as part of a definite national program. The committee recommends that similar comprehensive and detailed studies of other promising representative projects be undertaken.

It is urgent that such studies be initiated promptly. Most large water projects do not lend themselves to immediate construction even after their general features have been determined. Before actual construction involving large expenditures for labor and materials can begin, exact locations of structures must be determined by exploration of foundation conditions, structural designs then worked out, and general plans and specifications prepared. Cultural and economic surveys should be made, including the relations of the project to agriculture, forestry, transportation, industry, industrial trends, and general cultural development. Possibilities of multiple use, involving combinations among power, navigation, flood-control, supply, sanitation, and recreational features, should be thoroughly explored. Allocations of benefits and costs should be worked out. Sometimes plans for special legislation are necessary. These matters require time, as does acquisition of necessary lands. Heretofore it has been the custom to defer most of this detailed investigating and designing until the allotment or appropriation for a project has been made. This procedure has many disadvantages, especially the facts that it requires from 9 months to a year to prepare working plans, decisions must be made under pressure without adequate data, the work is never available to take up promptly a lag in employment, and planning on a scale wide enough to include many individual projects is prevented.

It is suggested not only that such studies be initiated promptly, but also that adequate appropriations, involving a substantial sum, be made to permit investigations on a scale which will bring in hand necessary information concerning representative projects in every section of the country.

The committee suggests the following as a representative partial list of projects for such studies:

(*a*) *North Atlantic Basins:* (1) The Connecticut River power, flood-control, and stream-pollution project in Vermont, New Hampshire, Massachusetts, and Connecticut;

(2) The Delaware River power, water-supply, and stream-pollution project in New York, Pennsylvania, and New Jersey;

(3) A study looking to the coordination of the hydroelectric power to be developed in northern New York, principally in the international section of the St. Lawrence, and the development of coal-generated, mine-mouth power in Pennsylvania, having in mind condensing water requirements, so as best to conserve the social, economic, and industrial interests of the States of New Jersey, New York, and Pennsylvania.

(*b*) *South Atlantic and Eastern Gulf Basins:* (1) The Potomac River stream-pollution, water-supply, and power project in Pennsylvania, Maryland, Virginia, West Virginia, and the District of Columbia.

(*c*) *Upper Mississippi and Red River of the North Region:* (1) The Red River water-supply and flood-control project in Minnesota, North Dakota, and South Dakota.

(*d*) *Missouri Basin:* (1) The Kansas City flood-control projects in Kansas and Missouri.

(*e*) *Ohio Basin:* (1) The Pittsburgh flood-control project in Pennsylvania, New York, and West Virginia.

(2) The Kanawha-Greenbrier-New River flood-control, power, and navigation project in West Virginia, Virginia, and North Carolina.

(*f*) *Southwest Mississippi and western Gulf basins:* (1) The Caddoa Dam and Reservoir on the Arkansas River in Colorado.

(2) The Conchas Dam and Reservoir on the South Canadian River in New Mexico.

(3) The Fort Reno Dam and Reservoir on the North Canadian River in Oklahoma.

(4) The Brazos Basin conservation and reclamation project in Texas.

(*g*) *Lower Mississippi region:* (1) The Coldwater-Yazoo River flood-control project in Mississippi.

(2) The St. Francis flood-control project in Missouri and Arkansas.

(*h*) *Colorado Basin:* (1) The interrelation of United States Colorado Basin projects in California, Arizona, Nevada, Utah, Wyoming, Colorado, and New Mexico.

(*i*) *South Pacific and Great Basin district:* (1) The economic aspects of the Central Valley irrigation, flood-control, power, and navigation project in California.

(*j*) *North Pacific district:* (1) The Grand Coulee High Dam irrigation and power project in Washington.

5. An Organization for Advisory Planning of the Use and Control of Water

In Section I, II–5, it was indicated that one of the lines of desirable fundamental action in respect to water resources is advance planning of their unified development over fairly long periods. Such planning cannot be effective if done casually; it must for basic physical, technical, and financial reasons be done by an appropriate national agency continuously engaged on the problem. The establishment of such an agency raises questions of organization. Therefore the committee not only recommends the establishment of such an organization, but offers suggestions concerning its form.

The only fields of endeavor in which comprehensive planning of the nature indicated has been tried and proved are engineering and industry. Engineering, in the construction of such projects as the Panama Canal, and industry, in the management of such enterprises as great multiple-plant corporations, have developed a form of organization and a technique for planning which offer pertinent prototypes for organizing national and regional planning of the development of water resources:

The engineering or industrial organization that proves to be successful is set up on a functional basis. Presented in an oversimplified explanation, construction of such an organization proceeds essentially by answering a series of related questions. The first question is: What is the objective to be achieved? Precise definition of the objective leads to a second question, What are the things which must be done to achieve the objective? Immediately a third question is asked: What is the relative importance of each of the things which must be done, and what are their technological relations? The resultant set-up, in their technical relations, of things which must be done is essentially a framework of the desired organization. The result is a functional—the theoretically perfect—organization.

Usually this theoretically perfect organization has to be modified to make it practicable, for it assumes—what seldom is the case—that all needed ways and means are available and perfect. Human and material factors are never all perfect. Therefore a fourth question, or group of questions, must be answered: What are the limitations in physical equipments and tools? What are the limitations in skills and capacities

of available personnel? What are the limitations imposed by customs, habits, and prejudices, and by existing human institutions? The ideal organization and procedure set-up is then modified in the light of answers to these questions, and a practicable working organization is evolved. It is approximately sound because, although representing a compromise, it is basically functional and yet is adapted to the circumstances.

Organizations in engineering and industrial fields have discovered that planning and execution are technically distinct functions, and that each must have its distinct organization set-up, although, of course, each is related to the other—has no reason for existence without the other.

Experience has discovered also that planning involves centralization, but not to the exclusion of decentralization. Increase of both centralization and decentralization results from increase of size.

Another thing which has been discovered is that although centralization must increase with increase of scope of operations, within this increased centralization a progressive decentralization develops. In other words, after the centralization of planning and coordination has reached a certain size, it is broken down into functional sections. It is in this manner that there have emerged (1) *directive coordinating planning* carried on by the general office of a great business having a score of plants in different localities; (2) *general-administrative coordinating planning* in each of these separate plants by its general office; (3) *departmental operative planning* by the major functional departments of each plant; and (4) *shop operative planning* by each operating unit of a department. Directive planning plans in terms of plants as units; general administrative planning plans in terms of major departments as units; departmental planning plans in terms of shops as units; and shop planning plans in terms of orders, machines, and workers.

The committee has approached the task of suggesting an organization for planning the use and control of waters with this engineering-industrial prototype in mind. It has asked itself the pertinent questions concerning objective; technical ways and means of achieving the objective; limitations and aids presented by customs, habits, and existing institutions; size of the particular planning task proposed; and the relations of centralization and decentralization.

The objectives as defined by the committee are in general:

(1) To develop the more productive uses of water resources—pure water supply, navigation, power, irrigation, recreation, and so on.

(2) To eliminate, modify, or neutralize harmful influences of waters—floods, erosion, and so on.

(3) To eliminate, modify, or neutralize man's harmful handling of waters—pollution, waste through irrational promotion of run-off and drainage, and so on.

(4) To accomplish the above purposes effectively from the point of view of technology, geographical conditions, existing public agencies, and the intelligent understanding and good will of citizens.

In considering the above objectives the committee is conscious that planning the use and control of water resources is but part of a larger national planning problem—planning the use and control of *all* natural resources; and that the latter planning task is but part of one still larger—planning the social and economic development of the Nation, of which utilization of resources is but one phase. These considerations in respect to the objectives and external relations of the proposed organization are indicated on the accompanying chart.

In considering the ways of achieving the above objectives, especially in the light of technological considerations and of agencies available, it became apparent to the committee that the water-planning organization should be concerned primarily, as an *advisory directive planning agency*, with the following functions:

(*a*) Discovery and formulation of desirable new projects.

(*b*) Evaluation of projects of local or regional origin.

(*c*) Designing the agreements and arrangements for carrying each project through to consummation.

(*d*) Promoting combined or coordinated efforts in securing hydrologic, economic, and other physical and social data.

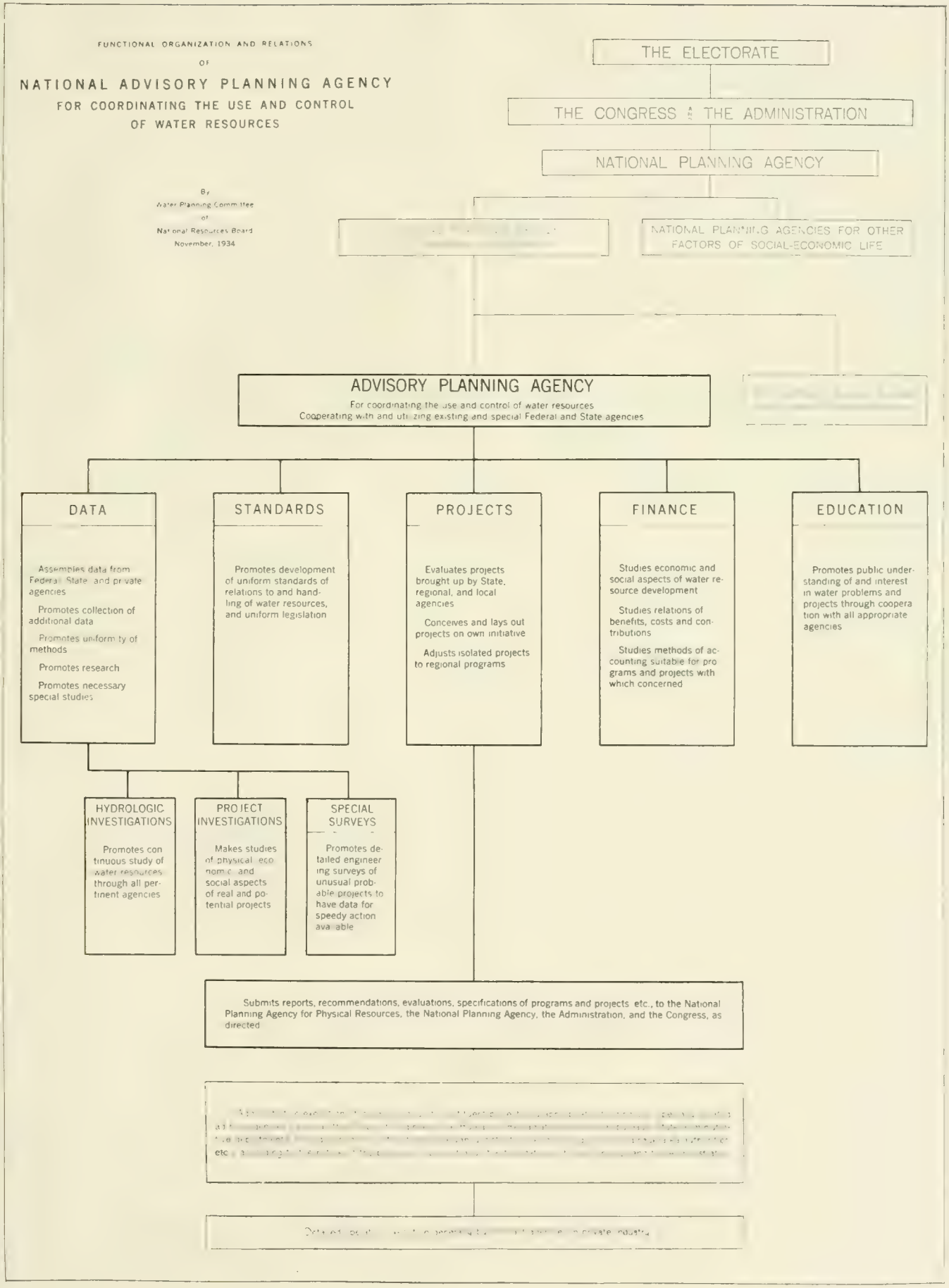
(*e*) Promoting standard practices and uniform legislation among political areas in their handling of waters.

(*f*) Promoting intelligent understanding of water problems and approval of proposed projects by the public.

(*g*) Working out such special problems as the relations between benefits, costs, and contributions, and in general devising a proper order of accounting for enterprises which are essentially social in their nature.

These ways of achieving the objectives are indicated on the chart.

In considering means or instruments, the committee found a number of institutions in existence or legally potential, suitable for general-administrative, administrative, or operative-planning agencies, and for instruments of execution. The suggested National Advisory Water Planning Agency is the only new agency which it appears at present desirable to create in the field of planning the use and control of water resources, but it is conceded that future experience under such a coordinating agency may indicate the need of other new associated agencies. Therefore on the chart is indi-


FUNCTIONAL ORGANIZATION AND RELATIONS
OF
NATIONAL ADVISORY PLANNING AGENCY
FOR COORDINATING THE USE AND CONTROL
OF WATER RESOURCES
By
Water Planning Committee
of
National Resources Board
November, 1934
THE ELECTORATE
THE CONGRESS & THE ADMINISTRATION
NATIONAL PLANNING AGENCY
NATIONAL PLANNING AGENCIES FOR OTHER FACTORS OF SOCIAL-ECONOMIC LIFE
ADVISORY PLANNING AGENCY
For coordinating the use and control of water resources
Cooperating with and utilizing existing and special Federal and State agencies
DATA
Assembles data from Federal, State, and private agencies
Promotes collection of additional data
Promotes uniformity of methods
Promotes research
Promotes necessary special studies
STANDARDS
Promotes development of uniform standards of relations to and handling of water resources, and uniform legislation
PROJECTS
Evaluates projects brought up by State, regional, and local agencies
Conceives and lays out projects on own initiative
Adjusts isolated projects to regional programs
FINANCE
Studies economic and social aspects of water resource development
Studies relations of benefits, costs and contributions
Studies methods of accounting suitable for programs and projects with which concerned
EDUCATION
Promotes public understanding of and interest in water problems and projects through cooperation with all appropriate agencies
HYDROLOGIC INVESTIGATIONS
Promotes continuous study of water resources through all pertinent agencies
PROJECT INVESTIGATIONS
Makes studies of physical, economic, and social aspects of real and potential projects
SPECIAL SURVEYS
Promotes detailed engineering surveys of unusual probable projects to have data for speedy action available
Submits reports, recommendations, evaluations, specifications of programs and projects etc., to the National Planning Agency for Physical Resources, the National Planning Agency, the Administration, and the Congress, as directed

cated the utilization of existing Federal and State agencies for research investigations, standardization, and education; the use of Federal and State administrative departments, and special organizations such as intrastate and interstate conservancy districts, as general-administrative agencies; and the utilization of construction and other enterprises in private industry for execution of projects with the accompanying detailed operative planning.

It is the committee's judgment that what is at present lacking is not suitable agencies of the various kinds needed for general administration and execution of projects, or dynamic local interests which conceive and propose water-development projects, but a planning and coordinating agency which can take national and regional points in view, bring projects together which are inter-related by fundamental drainage-area considerations, evaluate costs and benefits in large perspective, and assemble technical and financial means for consummation of projects conceived on a regional scale. Through such directive, coordinating planning there may be realized by all citizens of the United States the highest and most efficient utilization of resources which are regional and in some instances national in characteristic, and the most equitable distribution of benefits.

WATER PLANNING COMMITTEE

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Herbert S. Crocker, Consulting Engineer, Denver, Colo.
Glen E. Edgerton, Lieutenant Colonel, Corps of Engineers.[1]
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Morris L. Cooke, Consulting Engineer, Philadelphia,
Chairman.

[1] Representing General Markham.

PART III—SECTION II
INVENTORY AND USE OF WATER RESOURCES

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SECTION II
INTRODUCTION

Brief Inventory of the Water Resources of the United States

Sound policies for the conservation and use of the water resources of the United States and sound planning for their orderly development as parts of a well-conceived public-works program must be predicated upon two fundamental premises. The first is a knowledge of what constitute our water resources, and of how they differ in different regions. The second is the extent to which these water resources have been developed and utilized up to the present.

Considering the importance of water resources to so many phases of our agricultural, industrial, and cultural life, it is worth noting that hitherto no attempt has ever been made to present a description of the fundamental facts concerning these resources or the extent of their conservation and use for the country as a whole. The water-planning committee therefore undertook to collect data of this character as an essential basis on which to formulate its report and recommendations. To assemble such factual data from the numerous scattered and often inadequate sources within a period of a few months was no inconsiderable task. The first step was the preparation of reports from eight regional water consultants and their staffs covering the major drainage regions of the United States. The second step was to abstract from the approximately 500,000 words, 462 tables, 110 maps, and 165 diagrams comprising these reports, the condensed outline presented herein containing about 50,000 words, 19 maps, 12 tables, and 22 diagrams. This work and most of that in Section III has been organized and directed by Thorndike Saville, Professor of Hydraulic and Sanitary Engineering, New York University, who was granted leave of absence to act as Executive Engineer for the Water Planning Committee.

The regional and special consultants' reports bring together for the first time a comprehensive, and on the whole an adequate picture of the occurrence and use of the water resources of the United States. Nor are the reports mere compilations. They contain much original material, present data never before brought together in an orderly manner, and form a compendium of information and description which is of real significance and susceptible of wide use for numerous diverse purposes. Nothing like this has ever been done in any country, and the expense and expert effort involved cannot be adequately represented by the present abstract report.

In preparing the present report and the special reports on which it is based, assistance has been received from many public agencies and individuals. It is possible here to mention only the following:

Regional water consultants: H. K. Barrows, H. T. Cory, Brent S. Drane, O. N. Floyd, W. L. Huber, Joseph Jacobs, Charles H. Paul, L. K. Sherman.

Special consultants: W. S. Cullings, Willard E. Herring, Robert E. Horton, Sheppard T. Powell, Howard E. Simpson, Abel Wolman.

The Hydrologic Cycle

> *"All the rivers run into the sea, yet the sea is not full; unto the place from whence the rivers come thither they return again."*—Ecclesiastes 1:7.

To appreciate adequately the extremely complex and diverse phenomena producing and affecting the water resources of the country, some brief consideration should be given to the origin and disposition of the precipitation which falls as rain, snow, or hail. On page 262 there is presented a generalized picture of the never-ending cycle described in the ancient Biblical allusion quoted above. From this figure it will be seen that of the precipitation condensed from water vapor in the air most of it (perhaps 80 percent on the average) falls upon the surface of the earth. This is called "effective precipitation." The remainder is intercepted by vegetation from which it is evaporated to the air, or is directly evaporated while falling by encountering drier and warmer air layers than those where it originated. A considerable portion of the precipitation over any region is derived from local evaporation from that region. Only that part of the precipitation reflected as run-off in streams of the region draining into the ocean is derived from ocean sources.

Of the precipitation which reaches the surface of the ground, some immediately runs off over the surface and is carried away by streams and rivers; some is evaporated from the ground or water surfaces; and some percolates into the ground. The relative quantity of effective total precipitation disposed of in each of these ways varies greatly in different parts of the country because of the effect of topography, temperature, agricultural practices, soils, seasons, and vegetative cover.

NATIONAL RESOURCES BOARD
WATER RESOURCES SECTION
DISTRIBUTION OF
AVERAGE ANNUAL PRECIPITATION
IN THE
UNITED STATES
This chart is tentative and subject to correction
Lines show average annual precipitation in inches
Scale 1:13,875,000
100 0 100 200 300 400 500 600 Miles

Subject to the wide regional and local variations due to the causes just mentioned, it may be said that on the average, and considering the country as a whole, only between 10 and 50 percent of the total precipitation reaching the earth's surface is reflected in surface runoff; from 10 to 30 percent is evaporated from ground, water, or vegetation and from 40 to 60 percent percolates into the ground. Of that which percolates into the ground, a considerable portion is taken up by vegetation and used to produce vegetable matter or is transpired into the atmosphere from the leaves. Of the total effective precipitation, from 15 to 30 percent is disposed of in this way, leaving from 20 to 50 percent as ground water flow and storage, a considerable proportion of which ultimately reaches the streams and rivers through discharge by springs and seepage.

Ultimately all of the precipitation is evaporated back to the air, completing the hydrologic cycle shown in the figure.

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SECTION II
I. PRECIPITATION

The source of all water on or within the earth useful for the activities of man is precipitation, which results from the condensation of atmospheric moisture in the form of rain, snow, hail, dew, frost, etc. The water resources of the Nation are therefore fundamentally affected in the first place by the amount and seasonal distribution of precipitation, and in the second place by the various regional and local characteristics which control the relative influence of the several factors composing the hydrologic cycle described in the preceeding section.

Before presenting a general discussion of precipitation in the United States, it is desirable to have in mind certain major influences which exercise important effects upon its amount and distribution. The principal influences are:

(*a*) *Latitude:* Parts of continental United States extend from latitude 49° 23′ to latitude 25° 08′, a distance of 1,673 miles, but the greatest distance along any single meridian is 1,597 miles. Manifestly such extreme variations in latitude are bound to produce climatic differences profoundly affecting both precipitation and run-off.

(*b*) *Land and Water:* The relative influence of land and water areas as affecting precipitation depends upon a number of factors. The controlling water areas in the United States are principally the Pacific Ocean, the Gulf of Mexico, the Atlantic Ocean, and to a much less extent, the Great Lakes. The influence of these great sources of water vapor upon precipitation is materially affected by the configuration and extent of the land areas, by the direction of the prevailing winds, and by the passage of cyclonic storms. The map showing the principal physiographic provinces of the United States should be referred to in connection with this and succeeding paragraphs.

(*c*) *Prevailing Winds and Mountain Barriers:* Most of continental United States is within the zone of prevailing westerly winds. This general direction of wind movement is particularly effective during the winter months, as shown in figure 1a. It accounts for relatively high precipitation on the windward side of the principal mountain barriers, clearly indicated on the map of average annual precipitation. The great interior basins comprising the Colorado, Rio Grande, and Mississippi systems are affected, especially during the summer months, on account of the interior land areas comprising them being remote from large bodies of water.

Having an essentially continental climate, the land area of these basins tends to become colder than the oceans and Gulf in winter and warmer in summer. Hence, air pressure over the continent's interior is, on the whole, higher in winter and lower in summer than over the water masses. Because winds incline outward from a high pressure and inward toward a lower pressure region, there is a general tendency (interrupted by cyclonic disturbances to be described later) for winds during winter to move gradually out of the high-pressure area over the western part of the interior toward the south, east, and southeast, displaced by cold and relatively dry air from Canada. This is shown on figure 1a. As the winds in general, except for the Ohio Basin, flow southward, they become heated and the vapor capacity per unit volume is increased. Hence, we find everywhere in the interior of the United States, the least precipitation during the winter except for relatively small areas in the Ohio and Tennessee Valleys.

FIG 1A-PREVAILING WINDS IN JANUARY

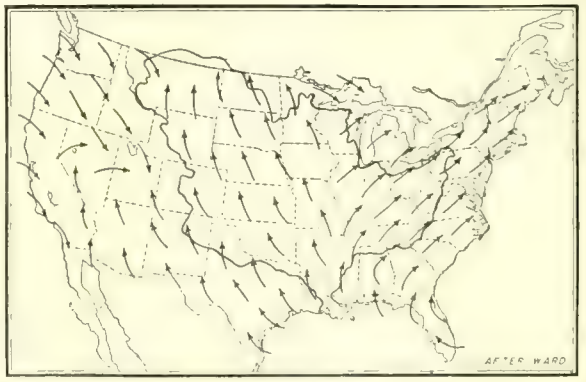
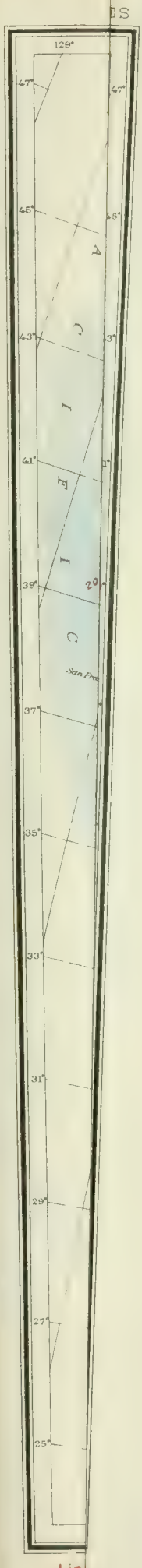


FIG 1B-PREVAILING WINDS IN JULY


129°
47°
45°
43°
41°
39°
37°
35°
33°
31°
29°
27°
25°
A
C
I
F
I
C
San Fra

NATIONAL RESOURCES BOARD
WATER RESOURCES SECTION
AVERAGE PERCENT DEVIATION
FROM
MEAN ANNUAL PRECIPITATION
IN THE
UNITED STATES
This chart is tentative and subject to correction
Lines show average percent deviation from mean annual precipitation
Scale 1:11,875,000
Miles

Conversely, during the summer, pressure over the interior of the continent is lower than over the oceans, and there is a general tendency for winds to flow inward. Because winds from the Atlantic and Pacific are cut off by mountain ranges, virtually the only gateway to the interior is from the Gulf. Hence warm winds which have passed over wide expanses of warm water enter and pass in a generally northward direction up the several river basins, as shown on figure 1b. As these winds flow northward they become cooled by contact with land areas, by contact with colder air to the north, and by being forced to rise over mountain slopes or over masses of denser, cooler air, by which the temperature is reduced through expansion.

Moisture brought from the Pacific Ocean by the Westerlies is precipitated as these winds rise over the Coast Ranges and the Rocky Mountains on their way eastward. Because of these mountain barriers, therefore, little or no moisture from the Pacific ever reaches the Great Plains. The Appalachians, being much lower, have less effect in preventing moisture-laden easterly winds from entering the interior. It is most fortunate for the United States that North America has no transverse mountain range comparable with the Himalayas of Asia. Such a range would divorce the Middle West from the mild, damp Gulf of Mexico winds, and cause arid or semiarid conditions in all of our North-Central States.

Between the Sierra Nevada-Cascade Mountains and the Rocky Mountains is a vast semiarid and arid region formerly known as the Great American Desert. Moisture-bearing winds from the west and from the east are blocked by mountains; the south opens on the desert of northern Mexico. Local convectional storms, the Westerlies, and occasional winds from the Gulf of Mexico bring a little rain to this area, but agriculture is possible only where water from the mountains is available for irrigation.

(*d*) *Altitude:*—In addition to their barrier effect, mountains and highlands in themselves constitute distinctive climatic provinces. On an average, temperatures drop 1°F. for every 330 feet increase in elevation. For this reason any notable upland has an average temperature many degrees below that of adjacent lowland areas. This cooling effect consequent upon expansion of air as it rises, chills moisture-bearing winds, causing them to precipitate appreciable quantities of rain and snow. Both the Rocky Mountains and the Appalachian highlands, therefore, are cooler and more humid than nearby parts of the interior plains. Precipitation is also higher on the eastern slopes of the Appalachians than nearer the Atlantic coast.

(*e*) *Cyclonic storms:*—Cyclonic storms are perhaps the most significant of the modifying influences which affect the precipitation of the United States. These cyclones, not to be confused with destructive tornadoes, are roughly circular low-pressure areas which drift across North America from west to east carried by the prevailing westerlies. Cyclones, or "lows", average nearly 1,000 miles in diameter, and travel at a rate of some 600 miles a day. Normally each cyclone is followed by an anticyclone, or high-pressure area. This irregular procession of cyclones and anticyclones usually enters from the North Pacific or Gulf regions as shown on figure 2a and 2b, crosses the Mississippi Valley, and, following the route of least resistance, usually leaves by way of the Great Lakes and the St. Lawrence lowland. Some of these storms, especially in winter, pass across central New York into northern and central New England.

This phenomenon is illustrated by daily weather charts of the United States Weather Bureau in figure 3. The following more or less typical features are shown:

(*a*) January 30. Entire country covered by high pressure with generally fair and cool weather.

(*b*) January 31. Low areas entering from Canadian Northwest and Gulf, accompanied by rain, and rising temperature.

(*c*) February 1. Both lows have moved eastward along typical paths, with increased intensity and moist, relatively warm winds from the water areas are flowing into the lows, producing heavy precipitation and rising temperature.

(*d*) February 2. The centers of the two lows have united off the Maine coast, with a "rain shadow" to the rear.

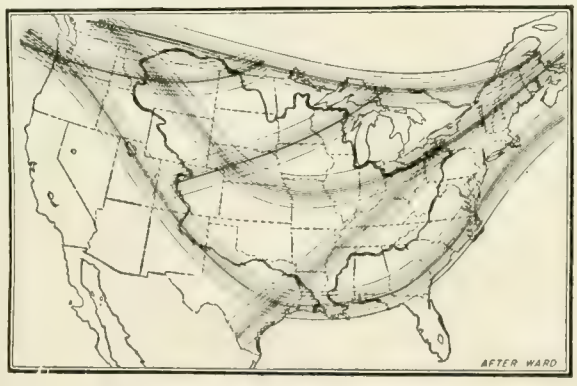


FIG 2A-GENERALIZED WINTER STORM PATHS

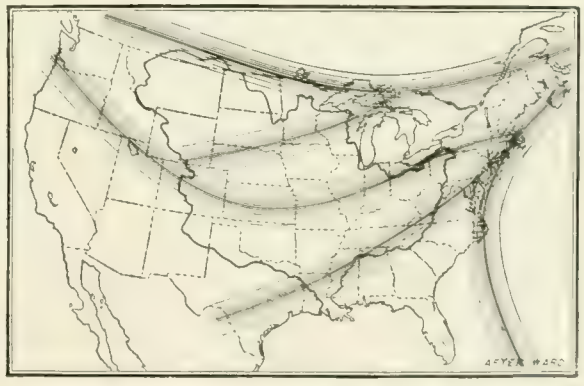


FIG 2B-GENERALIZED SPRING AND AUTUMN STORM PATHS

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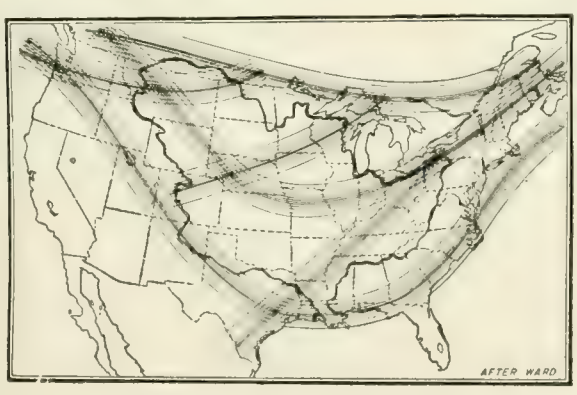

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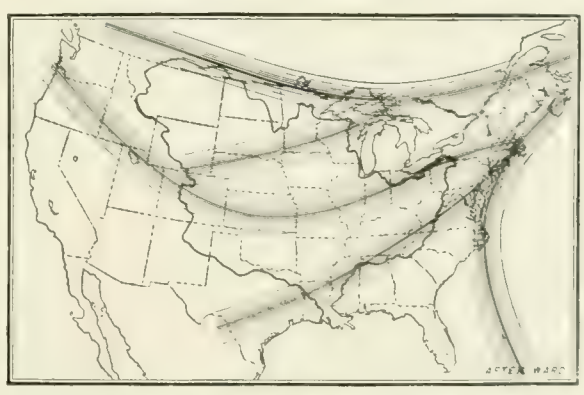


FIG 2B-GENERALIZED SPRING AND AUTUMN STORM PATHS

Areas of high pressure, or anticyclones, with clear and cool weather cover the remainder of the country.

Abrupt changes in wind direction, in temperature, and in precipitation characterize the passage of a well-defined cyclone. Except for their general eastward movement, cyclones obliterate all evidence of the prevailing westerlies. Winds locally blow toward the center of a low-pressure area in a counter-clockwise direction. This means that warm, damp, southern air flows into the southern and eastern parts of the cyclone, while cold and usually drier northern air moves into the northern and western sections.

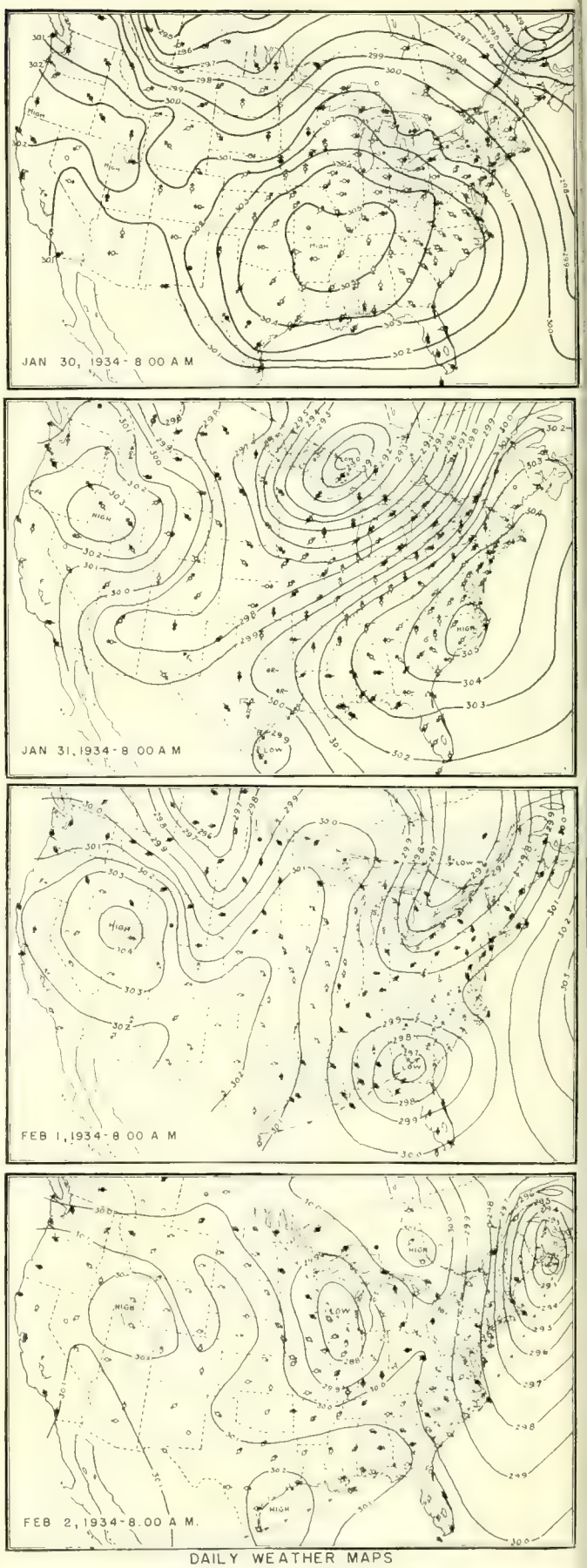
Practically all of the winter precipitation, and much of the summer rainfall in the northern United States is caused by cyclonic storms. Most of the rapid changes in weather so characteristic of this area also are directly accounted for by the passage of cyclones and anticyclones.

The tropical hurricanes, which originate in the Gulf of Mexico or the Carribean, are predominant as heavy rain producers in the late summer and fall. They move westward and then to the northeast, often causing excessive precipitation and floods along the Gulf and Atlantic coast, and sometimes affecting also the headwaters of the Ohio and Tennessee basins.

Average Annual Precipitation

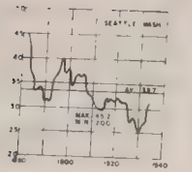
General: A map showing the average annual precipitation over the United States is the first of the maps accompanying this paper. It is a composite of maps compiled by the regional water consultants, and although subject to alteration as a result of further study and additional data, it is believed to represent with reasonable accuracy the general distribution of precipitation over the country. It is based upon more comprehensive data, especially for the West, than were available for the map published in 1922 by the United States Weather Bureau. The first point to be emphasized is that the amounts of precipitation shown are annual averages, and do not mean that every year these quantities may be expected. In some years they will be considerably greater and in others will be considerably less. Moreover, the relative distribution shown on the map will rarely occur in any one year. The map merely gives a picture of the annual average precipitation which may be expected in a long term of years. It does present an accurate delineation of relative wetness or dryness in various parts of the United States.

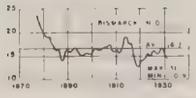
North Pacific Drainage: Were it not for mountain ranges the prevailing westerly winds from the Pacific would produce a fairly high and uniform precipitation, decreasing with distance from the coast. However, the Cascade Range introduces an important barrier, producing extreme precipitation conditions. As a result there occurs on the western slopes of these mountains the highest annual rainfall in the United States. This is most strikingly shown by the pictorial

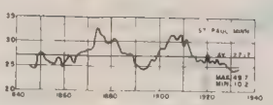


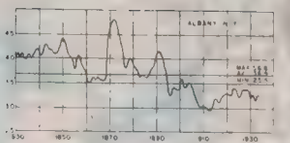
DAILY WEATHER MAPS
DATA FROM U.S. WEATHER BUREAU
ARROWS INDICATE WIND DIRECTION SHADED AREAS INDICATE PRECIPITATION

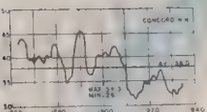
FIGURE 3

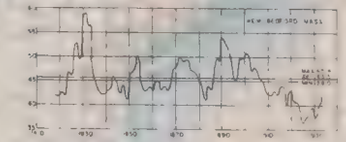


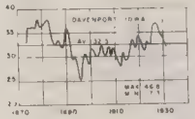


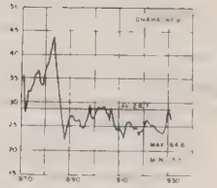


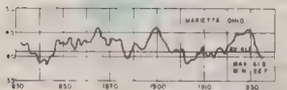


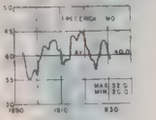


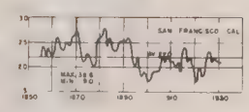


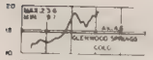


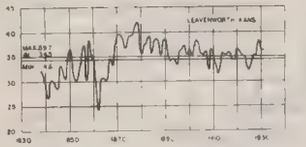


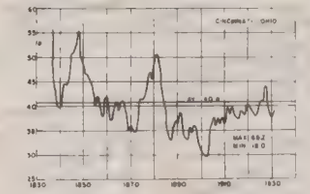


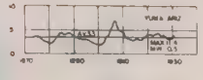


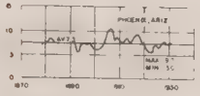


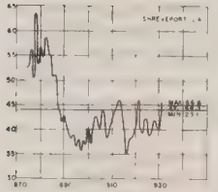


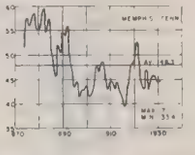


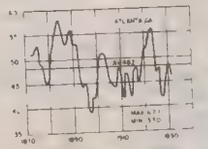


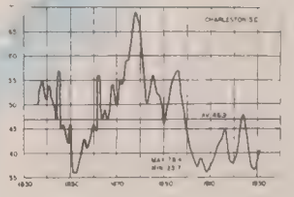


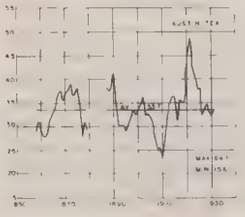












NATIONAL RESOURCES BOARD
WATER RESOURCES SECTION

MOVING AVERAGES OF PRECIPITATION

AT

TYPICAL STATIONS

IN THE

UNITED STATES

FOR CURVES ENDING IN 1931 THE FIVE YEAR AVERAGE WAS PLOTTED FROM MIDDLE OF THE FIVE YEAR PERIOD
FOR CURVES ENDING IN 1933 THE FIVE YEAR AVERAGE WAS PLOTTED FROM THE LAST YEAR OF THE FIVE YEAR PERIOD

representation of rainfall depths which accompanies this section. Although badly needed, there is a dearth of Weather Bureau stations in the higher altitudes, where the greatest precipitation occurs, but from stream-flow observations estimates of annual precipitation reaching as much as 250 inches seem justified. Average annual values of from 75 inches to 125 inches are fairly general west of the Cascades. Snow depths often reach 50 feet annually at the higher elevations.

Passing eastward from the crest of this range, the precipitation rapidly decreases to less than 10 inches on the lower portions of eastern Washington and Oregon and southern Idaho. As the Rockies of the Continental Divide are reached, there is a progressive increase in precipitation because of altitude, but the winds have then lost so much of their moisture that annual precipitation is only from 20 to 50 inches on the average over most of this territory. Over much of the Columbia Basin the precipitation is from 10 to 20 inches, the high average flow of the Columbia River being due to heavy precipitation upon headwater streams in the mountains.

South Pacific Drainage: Along the northern California coast where average annual precipitation exceeds 40 inches, the range is from 10 to 100 inches. In the San Francisco Bay region an average of from 20 to 30 inches is sufficient for agriculture. Farther south the 10 to 20 inches of annual rainfall, combined with high temperatures, creates semiarid conditions requiring irrigation for most agricultural purposes. This is also the case in much of the Sacramento and San Joaquin Basins.

Great Basin: With no outlet to the oceans, the topographic conditions of this region operate to produce an extremely low rainfall, varying on the average from 5 to 10 inches annually. Much of this area, including the Great Salt Lake Basin, is arid, nonagricultural in character, and consists of desert waste and barren hills. Local sources of water are heavily drawn upon for irrigation needs, and localities of any size, such as Salt Lake City, are frequently concerned with securing additional supplies from subsurface sources or even from more adequately watered areas outside of the Basin.

Colorado River Basin: Over most of this basin average annual precipitation ranges from 5 to 20 inches, varying in general with elevation. Local areas at high elevations, particularly in Wyoming and Colorado, have as much as 20 to 30 inches in the form of rain and snow. Precipitation over the basin as a whole will hardly exceed 10 inches, and therefore conservation of water by storage is essential for the irrigation requirements of agriculture.

Western Gulf Drainage: Average annual rainfall in this region varies from 10 to 15 inches over most of the Rio Grande Basin, increasing progressively and fairly uniformly eastward to as much as 55 inches in portions of Louisiana. High rainfall in the southeastern part of this drainage district is caused by proximity to the Gulf and the climatic influences consequent thereon.

Mississippi River Basin: An inspection of the map of average annual precipitation will show the following salient facts:

1. The lines of equal annual precipitation tend to run in a general north-and-south direction. This tendency is most pronounced west of the Mississippi. East of the river they tend to run northeast-southwest.

2. The annual rainfall is smallest on the west of the Mississippi Valley and increases gradually to a maximum to the east.

3. The only part of the Mississippi Valley having an average annual rainfall less than 10 inches is a small area centering in Big Horn County on the headwaters of the Big Horn River in the central western portion of Wyoming. This region is in a deep valley (elevation, 3,800 to 4,800 feet) surrounded by mountain ranges of 7,000 feet. The average annual rainfall is about 6 inches. The minimum annual rainfall of record (1.20 inches) occurred at Hyattville in 1900. At this station there are generally not more than 28 days per year when precipitation occurs, and for the area as a whole not more than 40 days per year having precipitation.

4. The Great Plains region has for the greater part an average annual precipitation between 10 inches and 20 inches. The northwestern portion has between 10 inches and 15 inches.

5. Farther east there is a relatively uniform band representing average annual precipitation between 20 and 30 inches extending nearly north and south. If this amount of rainfall could be depended upon each year, crop production would be secure. Unfortunately there are large variations from the average, often amounting to 50 percent or more, in the rainfall for any one year.

6. Throughout the central lowland region, the precipitation varies from 30 to 40 inches.

7. As the Appalachian Plateau is reached we find over the Ohio and Tennessee Basins average annual precipitation from 40 to 60 inches, increasing to the east. This is the best-watered portion of the Mississippi Valley affected by moisture-laden winds from both the Gulf of Mexico and the Atlantic Ocean. The rainfall is not only larger on a total annual basis, but is more equally distributed throughout the year than in regions to the west.

8. Table 1 shows the distribution of annual precipitation over the principal subbasins of the Mississippi. It will be noted from the last two columns that the relative water-producing abilities of the different portions of the Valley differ materially. Thus the Ohio Basin with less than 40 percent of the area of the Missouri, produces 82 percent as much precipitation on an areal basis.

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9. The maximum average annual precipitation (about 82 inches) occurs at Highlands, N. C., in the Blue Ridge Mountains. It is caused almost entirely by local topographic features inducing heavy rainfall from tropical hurricanes and from local thunderstorms in summer. The maximum annual rainfall of record was 111.20 inches in 1915.

Red River, Great Lakes, and St. Lawrence Drainage: The basin of the Red River of the North comprises a region of relatively low precipitation, varying from 20 to 25 inches annually. The precipitation characteristics of the area tributary to the upper Great Lakes are affected significantly by proximity to the Lakes themselves. A fairly even distribution of from 30 to 35 inches obtains over most of this region. The precipitation over areas tributary to Lakes Erie and Ontario and the St. Lawrence Basin is variable, due to topographic factors. Climatic conditions are complex on account of the influence of both cyclonic storms from the west and coast storms to the east. The average annual precipitation varies from 35 inches in the lower altitudes to 45 inches over the headwater streams of the Adirondacks.

North Atlantic Drainage: A tendency of storm paths from the west and south to converge over portions of this area produces a relatively high annual precipitation of marked uniformity throughout the year, and amounting to from 40 to 50 inches on the average. Precipitation is higher in the mountain areas, reaching a maximum of about 80 inches annually on Mount Washington in New Hampshire.

South Atlantic and Eastern Gulf Drainage: The low-lying coastal plains of this region, rising to the Piedmont Plateau and Appalachian Mountains, produce topographic features profoundly affecting precipitation. The average annual precipitation is fairly uniform over the region, amounting to from 50 to 60 inches near the coast, 40 to 45 inches over the Piedmont Plateau, and reaching 50 to 60 inches in the mountains.

TABLE 1.—*Annual precipitation in the Mississippi Valley*[1]

Subbasin	Drainage area	Percent of entire basin	Average annual rainfall	Average annual snowfall	Total precipitation	Equivalent proportion of total	
						Inches	Per cent
	Square miles		*Inches*	*Inches*[2]	*Inches*		
Missouri	528,850	42.3	18.91	3.90	22.81	9.62	30.9
Upper Mississippi	187,850	16.0	28.72	3.10	31.82	4.78	15.4
Ohio	203,900	16.5	42.10	2.60	44.70	7.29	23.4
Arkansas	186,000	14.9	28.00	1.30	29.30	4.36	14.0
Red	90,000	7.2	39.40	.60	40.00	2.88	9.3
Lower Mississippi	54,300	4.3	49.37	.50	49.87	2.17	7.0
Total	1,250,900	100.0				31.10	100.0
Average			28.31	2.79	31.10		
			91%	9%	100%		

[1] From Rainfall Characteristics of the Mississippi Drainage Basin, by H. C. Frankenfield, Trans. Am. Soc. C. E., vol. 93, 1929.

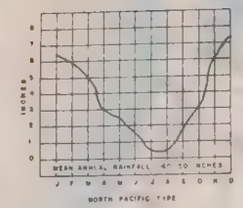
[2] Rainfall equivalent.

Variation in Annual Precipitation

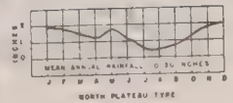
The average of the annual precipitation over a considerable period of years, such as is shown by the accompanying map, is no indication of what the rainfall may be in any one year. That is, rainfall for a single year, or for a succession of wet or dry years, may depart widely from the long-period average. The degree to which annual rainfall is likely to depart from the average is indicated on the accompanying map of deviation which shows lines of average percent deviation from the mean annual precipitation. This map is new and is subject to modifications as a result of further study but it indicates the wide range in conditions over the country. It will be observed that in the more humid areas of the East and Northwest, the average deviation is low, and that it becomes much higher in the arid regions. This has important economic consequences and explains the necessity for extremely large storage reservoirs in the arid portions of the country. In New England there is a 50-50 chance that the precipitation in any one year will not differ from the average by more than about 10 percent, while there is an equal probability that in parts of the Imperial Valley of California it may depart 40 to 50 percent from the average. Moreover, the significance of these relative probabilities of departures from the mean is accentuated by the respective magnitudes of the average rainfall. Thus in New England, with an average of around 45 inches, a variation of 10 percent below would still yield 41.5 inches, which is reasonably adequate. But in the Imperial Valley the annual average is only 5 inches or less, and a variation of 40 percent below would yield only 3 inches, which has tremendous implications with respect to agriculture, and the amount of water required from sources other than local rainfall. In general the widest variations from the average annual precipitation occur where such variations are most serious, namely, in the arid and semiarid regions.

Another method of studying variations in annual precipitation, particularly with regard to long-period trends is by means of moving averages. A map showing 5-year moving averages at selected stations throughout the United States is presented with this report. It will be seen that there are always successive periods of high and low precipitation; that these periods do not have any constant time interval between them; and that they do not synchronize in different parts of the country or even in nearby regions.

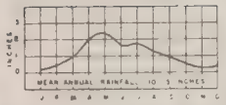
While much of the country has been experiencing a period of deficient rainfall for the past few years, as indicated by the map of moving averages and by figure 4, every unbiased study made by the Weather Bureau and other qualified observers indicates that such low periods in precipitation will be succeeded by periods of



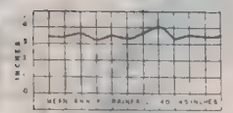
NORTH PACIFIC TYPE



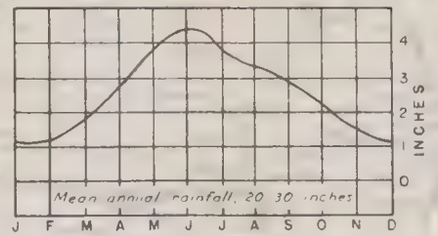
NORTH PLATEAU TYPE



EASTERN ROCKY MOUNTAIN FOOTHILLS TYPE



NEW ENGLAND TYPE



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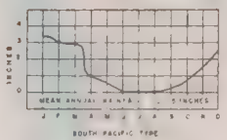
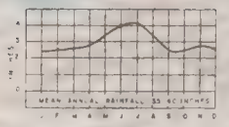


SOUTH PACIFIC TYPE



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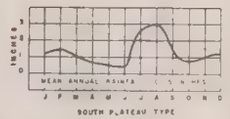

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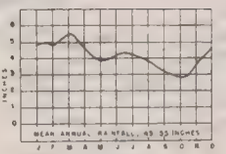

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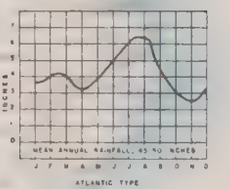
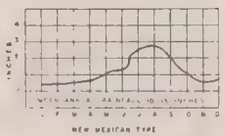


ATLANTIC TYPE



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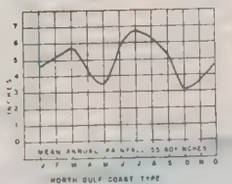

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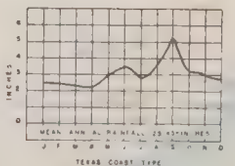
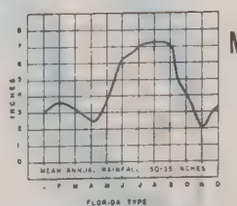


TEXAS COAST TYPE



FLORIDA TYPE

NATIONAL RESOURCES BOARD
WATER RESOURCES SECTION

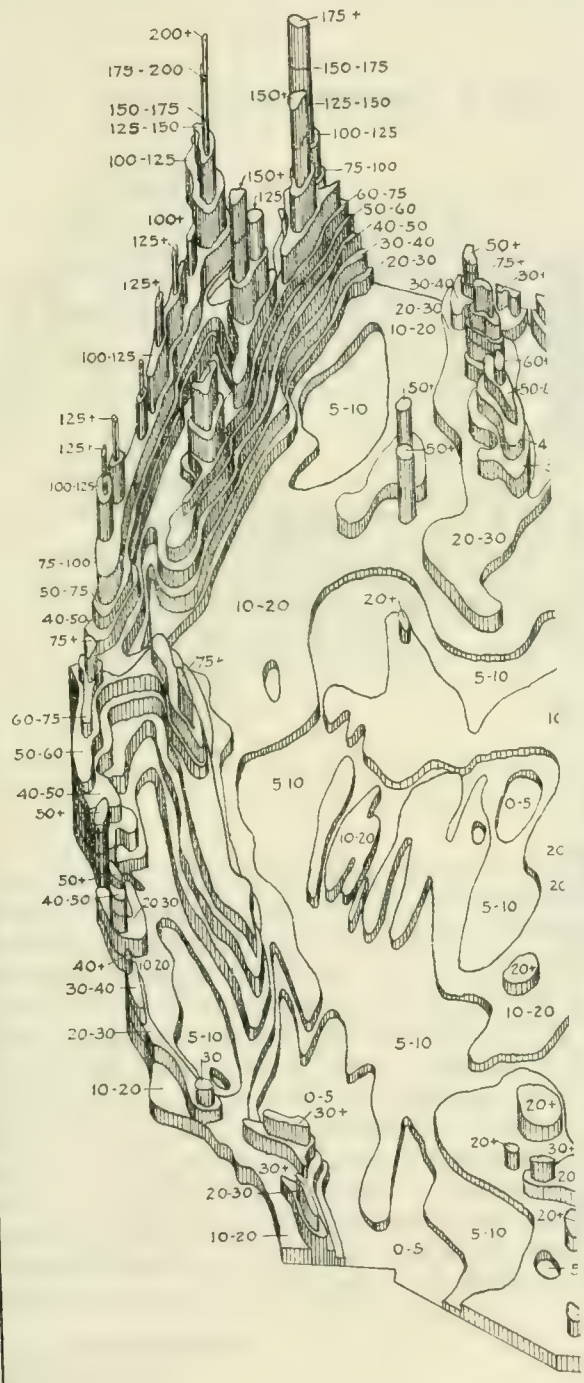
DISTRIBUTION OF

MONTHLY PRECIPITATION

IN THE

UNITED STATES

After Ward—Climates of the United States. Ginn & Co., 1925.



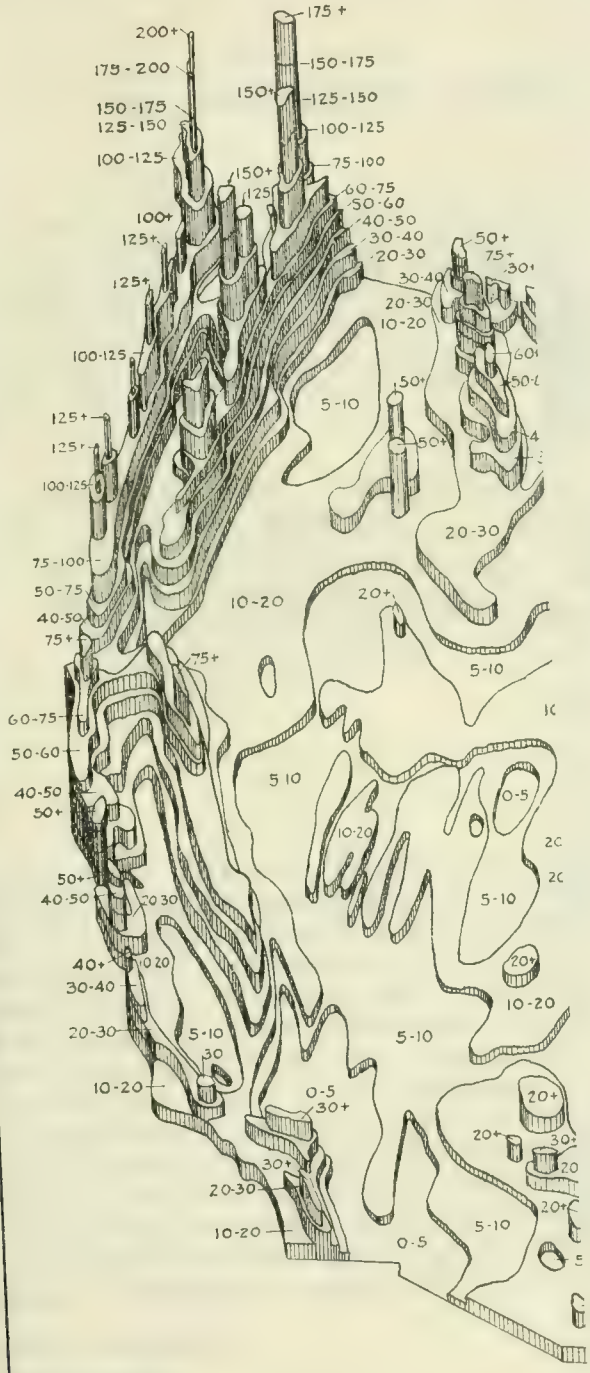
PICTORIAL REPRESENTATION O

DEPTHS OF MEAN ANNUAL PRECIPITAT

IN THE

UNITED STATES

FIGURES DESIGNATE INCHES OF PRECIPIT



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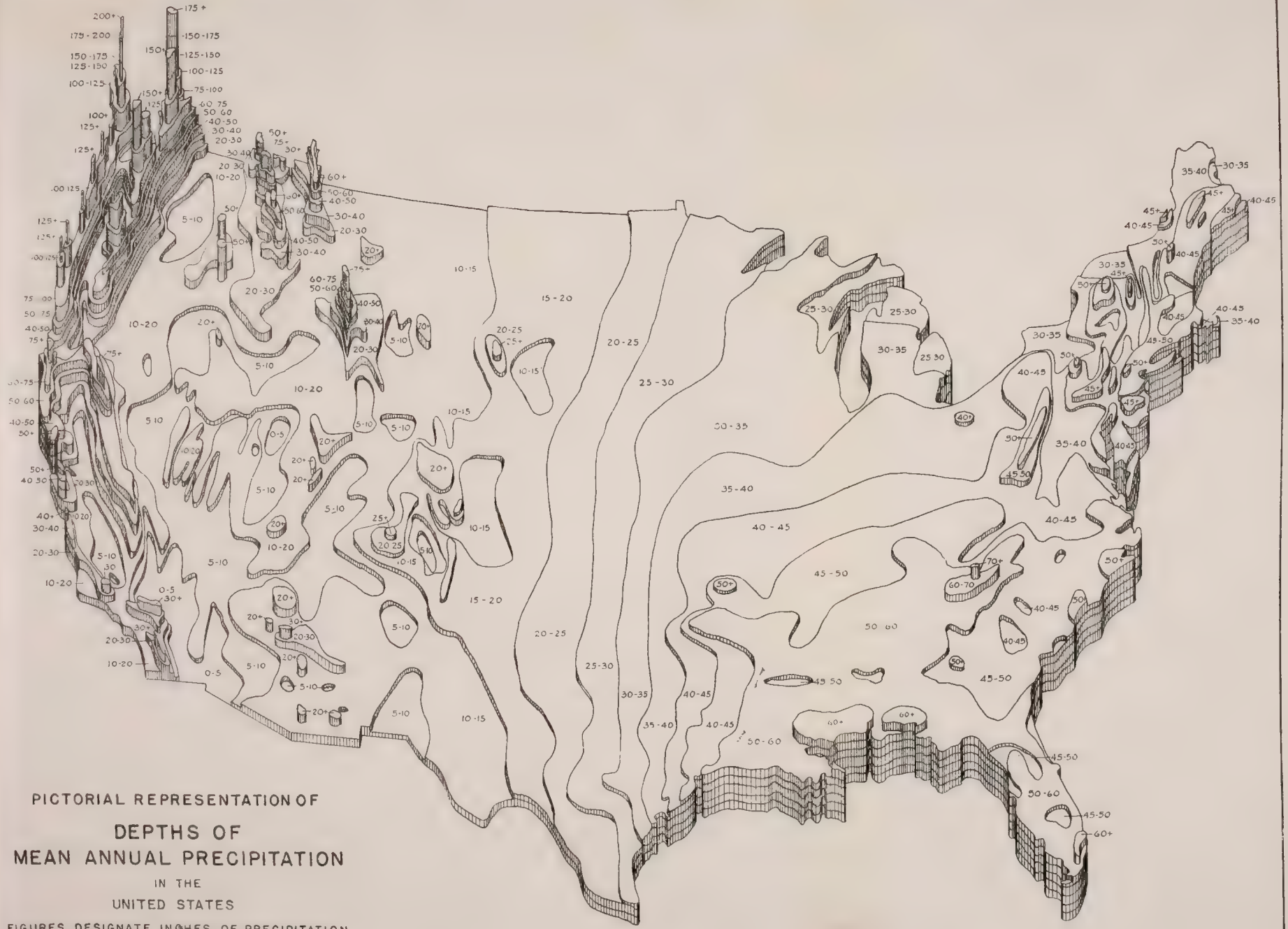

92588—34. (Face p. 298)

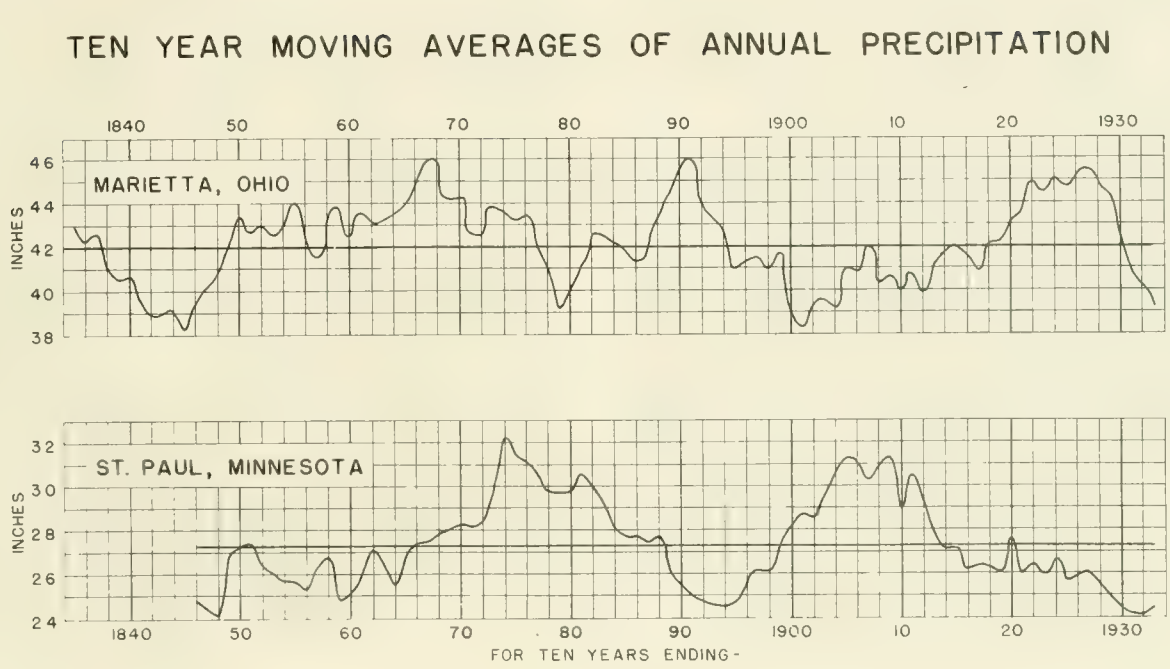

FIGURE 4

high precipitation, and there is every reason to believe that within the next few years precipitation will tend to increase over the regions affected by the recent droughts.

Substantiation of this forecast is to be found from long-term records of precipitation such as those shown on figure 4, presenting data for 98 years and 88 years at Marietta, Ohio, and St. Paul, Minn., respectively. It will be noted that periods of low precipitation even greater than that now being experienced have occurred, always to be succeeded by periods of high precipitation. However, the need for conservation by storage of run-off in years of high precipitation for use during years of low precipitation is evident, since neither the time of occurrence nor intensity of low periods can be predicted.

Seasonal Distribution of Precipitation

For many human activities, particularly those of irrigation and power development, not only the amount of precipitation and run-off must be considered, but the distribution throughout the year. On the map there have been located diagrams showing the average monthly distribution of rainfall according to general types characteristic of various parts of the country.[1] These diagrams require no explanation, but only the comment that in those sections of the country having a distinctly seasonal distribution of precipitation, particularly regions west of the Mississippi, storage reservoirs are especially important to conserve run-off precipitation for use when it is most needed.

Evaporation

Water losses by transpiration from vegetation and by direct evaporation from land and water surfaces are very considerable, as has been indicated in the discussion on the hydrologic cycle. There is such a paucity of accurate information regarding the amount and variation of these losses, however, that no presentation of maps or tables indicative of conditions throughout the country is attempted. Data on evaporation from water surfaces are particularly important, and many more evaporation stations should be established.

Available information concerning average annual evaporation from reservoir surfaces permits the formulation of some generalized but significant conclusions.[2] Water losses by evaporation range from a minimum of about 20 inches in the cool, damp northeastern and northwestern parts of the country to a maximum of more than 80 inches in the hot, dry Imperial Valley of California. East of the ninety-seventh meridian annual evaporation gradually increases from 20 inches or less in the vicinity of the Great Lakes to almost 50 inches near the Gulf coast. Farther west complex mountains, basins, and valleys

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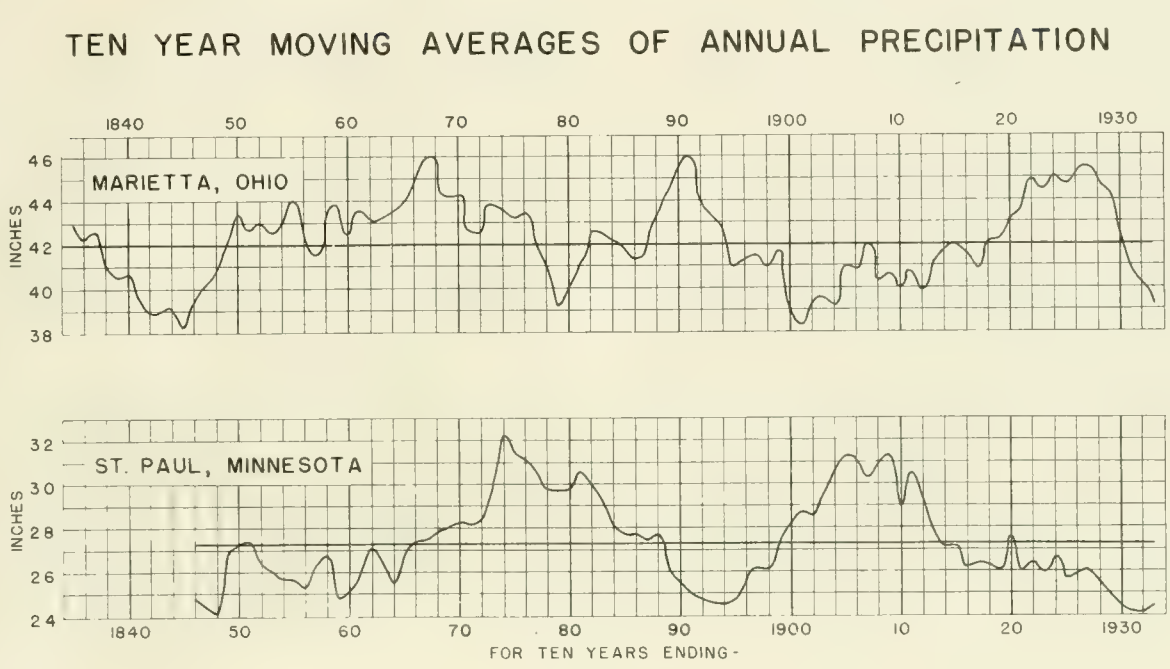

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cause an irregular evaporation pattern, but the Pacific littoral is characterized by evaporation of less than 40 inches while the southwestern interior has more than 60 inches of evaporation each year.

Collection of Basic Data

The need for accurate data with respect to precipitation and water losses is evident as basic to any adequate planning for the conservation and use of the water resources of the United States. The Weather Bureau maintains about 4,500 precipitation stations throughout the country. The majority of these are operated by voluntary cooperative observers. Data are published with fair promptness and in usable form.

The regional water consultants recommend that additional stations be located at certain strategic points, particularly at locations in the higher altitudes where there is a real dearth of accurate information that more effort be given to collection and publication of rainfall intensities for less than 24-hour periods; that much more attention be given to measurements of depth of snow in certain regions; that consideration be given to methods for increasing and evaluating the accuracy of data being collected; and that distinct improvements in publication and availability of basic data are possible.

There are less than 100 evaporation stations now being operated in the entire country, and most of these are west of the Mississippi. There is a distinct and pressing need for many more stations, installed and operated under standardized procedures by a central agency.

NATIONAL RESOURCES BOARD
WATER RESOURCES SECTION
DISTRIBUTION OF
AVERAGE ANNUAL RUNOFF
IN THE
UNITED STATES
This chart is the first of its kind prepared and published since 1908 It is tentative and subject to correction
Lines show average annual runoff in inches
Scale 1:8,750,000
100 Miles

SECTION II
II. SURFACE WATERS

Surface waters as here considered represent that part of the precipitation appearing as run-off from the surface of the ground and in streams. It represents the part of the rainfall that remains after the demands of plant growth (including transpiration), soil absorption, and surface evaporation (usually referred to as water losses), have been satisfied. These water losses increase in general from approximately 20 inches annually in the Northern States to about 40 inches in the extreme South. These figures do not apply, however, to the more arid regions or to the central portions of the country.

On the accompanying map, showing lines of equal annual run-off, the delineations are regarded as being most nearly accurate in those regions where the annual water losses were known and were used to supplement stream flow data. The only previous map of this kind was prepared by Henry Gannett, of the United States Geological Survey, about 1908. Since then much additional data have become available. The map represents an attempt to portray the average annual yield of water from land areas. It does not, therefore, necessarily show the actual flow in the rivers at the points where the lines of equal annual run-off cross them. Nor can it adequately portray changes in natural run-off that are produced by the activities of man, such as irrigation and drainage.

The variations in average annual water yield shown on the map are due chiefly, of course, to variations in rainfall, the proximate causes of which have been indicated in the preceding section. Indeed, the close similarity in pattern between the map of annual rainfall and that of annual run-off is notable and to be expected. Areas of high and low rainfall should be expected to produce high and low run-off respectively, and such is the case. A comparison of the two maps indicates clearly, however, that the proportion of rainfall appearing as run-off is by no means constant over the country. This proportion varies from a maximum of more than 75 percent on areas supplied from the snow fields of the Cascades, to less than 10 percent over large areas of the Great Basin and the Intermontane area. It increases to between 30 percent and 50 percent over the west slopes of the Rockies, and then decreases rapidly to from 30 percent to 3 percent over the Great Plains.

Still moving eastward, the proportion of rainfall appearing as run-off increases, as the Central Lowlands (see physiographic province map) are passed until in portions of the Tennessee Basin it reaches as much as 55 percent to 65 percent. On the east side of the Appalachians there is a fairly uniform relation, ranging from 40 percent to 50 percent in the North Atlantic drainage and from 35 percent to 45 percent in the South Atlantic drainage. The foregoing statements indicate clearly that as run-off is a residual product from rainfall, and as intermediate water losses vary greatly, there can be no simple or constant relation between rainfall and run-off.

The run-off map is indicative of the variations in water yield from land areas over the country and is subject to correction as further study is given to the matter and as more data becomes available.

By reference to the map it may be seen that areas draining the Cascade and Sierra Nevada Mountains have a high yield, particularly toward the north, where yields as high as 75 inches annually are common, and a maximum average run-off of 175 inches is estimated for small areas. Between these mountains and the Coast Ranges there are lowland areas, long and relatively narrow, of low yield. Throughout the vast area between the Cascades and Sierra Nevadas on the west and the Continental Divide on the east, the yield also is very low.

Passing eastward from the Continental Divide to about the longitude of central Kansas, a progressive decrease in annual run-off is observed, with a minimum of less than 1 inch over considerable areas. From central Kansas eastward there is a fairly uniform increase that culminates in the Appalachian range, in the southern portions of which the run-off is in excess of 45 inches in places. From the eastward slopes of the Appalachians to the Atlantic coast the annual run-off decreases more or less progressively to yields between 20 inches and 10 inches in the northeastern and southeastern parts of the country, respectively.

In the areas bordering the Great Lakes and the Gulf of Mexico, respectively, the rather uniform longitudinal changes in annual run-off that have been noted above are lacking. Due to the influences of these bodies of water in causing increased rainfall nearby, a corresponding slight increase of run-off occurs, as compared with that from adjacent areas farther inland.

Regional Descriptions

For convenience in discussing the surface waters of the country and their run-off characteristics, the fol-

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Regional Descriptions

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lowing descriptions will be related to specific regions (see map, p. 276) based in general on those used by the surface water division of the United States Geological Survey. In connection with the following discussion attention also is called to accompanying map showing characteristic hydrographs of monthly stream flow at selected stations in the several drainage divisions.

North Pacific Drainage

The Columbia River, its tributaries, and a few short rivers draining the slopes of the Coastal Range and the western slopes of the Cascades comprise the major surface waters of this district. Natural lakes are found along the Cascade Range, in southern Oregon, in the Idaho panhandle, and in the Rockies of Montana and Wyoming. This district has the greatest variation in average annual run-off to be found anywhere in the United States, with a maximum of 175 inches (12.9 cubic feet per second per square mile) in the Olympic Mountains in Washington, and a minimum of almost nothing in the Columbia Basin some 200 miles to the southeast, near the mouth of the Snake River. The annual run-off increases in general from 50 inches (3.7 cubic feet per second per square mile) along the Pacific coast to over 100 inches (7.4 cubic feet per second per square mile) in the Coastal Range, decreases thence to around 20 inches (1.47 cubic feet per second per square mile) in the valley of the Willamette and the Puget Sound lowland and than increases again from 50 to 100 inches (3.7 to 7.4 cubic feet per second per square mile) or more in different parts of the Cascade Mountains. East of the Cascade Range a rapid decrease in run-off takes place, with the entire area between the Cascade Mountains and the Rocky Mountains having a run-off of less than 5 inches (0.37 cubic feet per second per square mile). Average annual yields of 1.85 to 2.22 cubic feet per second per square mile are found to the east in the higher elevations of the Rockies and spur ranges.

The streams in eastern Oregon, fed by early melting snows, normally reach their annual maxima during the months from December to February, inclusive, with flashy flow during this period. Elsewhere, especially where streams originate in the mountains, the maximum flows occur generally from April to June. Minimum flows occur in August and September in Oregon and Washington, and in January and February in Montana and Idaho. Relative uniformity of flow in the region is promoted materially by the presence of several glaciers and large snow fields.

South Pacific Drainage

The principal rivers of this district are (*a*) those draining the west slope of the coastal range, and (*b*) those belonging to the Sacramento and San Joaquin systems of the Great Central Valley of California. The coastal streams have the greater run-off, varying however, from 15 inches (1.1 cubic feet per second pe square mile) in Northern California to 3.7 inches (0.2 cubic foot per second per square mile) in the San Francisco area, and to a minimum of 1 inch (0.07 cubic foot per second per square mile) in the extrem south. The Sacramento and San Joaquin Rivers ar fed by a large number of short tributaries whose run-of characteristics depend on the location and nature o their sources. The Feather River, a tributary of the Sacramento, is typical of those streams that originate at higher altitudes and are fed mainly by melting snow. This results in a regularly increasing and decreasing hydrograph (shown on accompanying map), with the maximum monthly flow in June. The Putah River, also a tributary of the Sacramento River, originates in the foothills and its flow depends almost wholly on rain. Its maximum monthly flow is in the rainy months of January and February, during which more than 50 percent of the total annual flow occurs. In July, August, September, and October it is almost dry.

The Great Basin Drainage

East of the Sierra Nevada Range there is very low run-off, averaging about 0.5 inch (0.036 cubic foot per second per square mile) yearly in the Great Basin as a whole, and 2.2 inches (0.16 cubic foot per second per square mile) in the Salt Lake Basin. No streams in these large areas discharge into the ocean; all of them flow into lakes or sinks. Many of the lakes disappear in summer, due to surface evaporation. In the case of sinks there is no surface accumulation, the water being absorbed almost immediately after it reaches them. As a result of these conditions, the utilizable water supply of the region must come largely from ground-water sources, which unfortunately are severely limited in quantity.

The Colorado River Basin

The Colorado River has five major tributaries: The Green River and Upper Colorado, rising in the Rocky Mountains in Wyoming and Colorado, and the San Juan, Little Colorado, and Gila rivers, entering from the divide in Colorado and New Mexico. The Green River and Upper Colorado are typical snow-fed streams with high run-off and a relatively uniform flow throughout the year. The Upper Colorado has an average annual run-off of 16 inches (1.2 cubic feet per second per square mile) from the drainage area of the upper reaches and 5 inches (0.4 cubic foot per second per square mile) from the total drainage area above the mouth of the Green River. The Green River run-off equals 4 inches (0.3 cubic foot per second per square mile) average annually from its total drainage area. The high yield of the upper reaches of these tributaries

is indicated by the fact that 80 percent of the flow of the Colorado River, exclusive of the Gila, is received from the drainage area lying above the mouth of the Green. In contrast, the run-off of the San Juan and Little Colorado Rivers, fed by sporadic rains and infrequent snows, results in a low annual run-off of 0.27 inches (0.02 cubic foot per second per square mile) for the Little Colorado River and 2 to 10 inches (0.14 to 0.7 cubic foot per second per square mile) for the San Juan River drainage area.

The Gila River has quite different characteristics from the other tributaries of the Colorado. Its peak flow may occur in almost any month, because the run-off is due largely to erratic precipitation of the cloudburst type. The greatest extremes in run-off in the entire Colorado Basin are those on the Gila River at whose mouth under natural conditions flows have occurred varying from zero to a maximum of 350,000 cubic feet per second (5.8 cubic feet per second per square mile). The flow in the Gila River has been reduced progressively, as diversions have been made for consumptive uses, chiefly irrigation.

At Yuma, Ariz., near the mouth of the Gila River, the mean annual discharge of the Colorado River varies from 36,000 cubic feet per second, equivalent to 2 inches (or 0.147 cubic foot per second per square mile) in the maximum year, to 6,800 cubic feet per second or 0.38 inch (0.028 cubic foot per second per square mile) in the minimum year. Due to the period of low run-off now prevailing over the Colorado Basin the mean yearly flow for 1934 at Lee's Ferry, 250 miles from Boulder Dam was somewhat less than 35 percent of the 40-year mean of 20,000 cubic feet per second. The latter is equivalent to 1.2 inches (0.09 cubic foot per second per square mile).

Western Gulf Drainage

The Rio Grande, with its major tributary the Pecos River, and several smaller streams that enter the Gulf of Mexico between the Rio Grande and the Mississippi River comprise the major rivers of this district.

Except for run-off as high as 10 inches in small areas in the mountains of northern New Mexico, the annual run-off increases generally from west to east, with a mean of less than 1 inch in western Texas to and a maximum of over 20 inches in Louisiana. Except for the Guadalupe River, which receives its run-off largely from underground sources, many of the streams of Texas that enter the Gulf of Mexico cease to flow during long dry periods. Excessive floods are common on the smaller streams; they are often caused by cloudbursts, and result in some of the highest flood intensities recorded in North America. The Rio Grande itself does not have the high flood flows common to the smaller streams.

The Mississippi River Basin

In a general way, the Mississippi Basin may be divided into run-off provinces that correspond roughly to the physiographic provinces.

In the Rocky Mountains, the run-off is generally high over small areas. In northern Montana and Yellowstone Park, the headwater areas of the Missouri and Yellowstone, average annual run-offs of 10 to 15 inches (0.7 to 1.1 cubic feet per second per square mile) are caused by heavy winter precipitation. Farther south, in the Colorado Rockies, the North Platte, South Platte, and Arkansas Rivers rise near an area of 20-inch run-off, to the south of which in turn the run-off decreases rapidly to a minimum of less than 1 inch in the Trans Pecos Highlands of New Mexico.

East of the Rocky Mountains, in which the major western tributaries of the Mississippi have their sources, the run-off in the Great Plains area generally falls to an average annual value of less than 1 inch (0.07 cubic foot per second per square mile), increasing again to 3 inches near the upper Mississippi and to 15 inches on the lower river. This variation is reflected strikingly in streamflow characteristics. Thus the Missouri River, while its drainage area comprises 43 percent of that of the Mississippi, contributes only about 14 percent of the flow of that river, largely because much of its course lies in the semiarid Great Plains. At Fort Benton, near the headwaters, the average annual recorded flow of the Missouri is 4.3 inches (0.31 cubic foot per second per square mile). Farther down, at Wolf Point, Mont., it is only 1.1 inches (0.08 cubic foot per second per square mile), while near the mouth of the river it is 3.9 inches (0.28 cubic foot per second per square mile).

Run-off and flow conditions similar to those of the Missouri Basin are found in the southwest Mississippi River drainage, including the Red, Arkansas, and White systems. Here, however, a relatively smaller proportion of the total drainage area has a run-off of 1 inch or less, while the run-off from the lower third of the district varies from 3 to 15 inches (0.22 to 1.1 cubic feet per second per square mile). The result is that the southwest Mississippi drainage, while comprising about 22 percent of the total Mississippi Basin, is estimated to contribute only 17 percent of the flow of the Mississippi.

Gagings show the average annual flow of the Arkansas River to be about 2.2 inches (0.16 cubic foot per second per square mile) at Pueblo, Colo., 0.28 inches (0.02 cubic feet per second per square mile) at Syracuse, Kans., and 2.8 inches (0.20 cubic foot per second per square mile) at Van Buren, Ark.

Near the dividing line between the Great Plains and the Central Lowlands, there is a marked increase in run-off, sharper in the south than in the north. In the northern Mississippi drainage, above the mouth of the

Missouri, in which the major tributary systems are those of the Des Moines and Minnesota Rivers on the west and Wisconsin and Illinois on the east, the run-off is fairly uniform, averaging about 10 inches. In the headwater regions in Minnesota it is nearer 3 inches, however, while in eastern Wisconsin the higher rainfall near the Great Lakes brings the average annual run-off up to 15 inches over a restricted area.

The upper Mississippi drainage includes 14 percent of the total Mississippi Basin, and it is estimated that it contributes 14 percent of the flow of the Mississippi River at its mouth. This contribution, it will be noted, equals that of the vast Missouri drainage area. The average annual flow of the Mississippi, as it leaves the upper basin region, is estimated at 100,000 cubic feet per second.

South of the mouth of the Missouri, in the Ozark Highlands and the Coastal Plateau, there is a marked increase in run-off, due to the influence of storms from the Gulf. Here the run-off reaches 15 to 20 inches immediately east of the main river.

The lower Mississippi River drainage includes in general the alluvial portion of the river below Cairo, and the surface waters comprise the main stem and the small tributary streams and bayous. The mean annual flow at the mouth of the Mississippi is estimated at 695,000 cubic feet per second, equal to 0.56 cubic feet per second per square mile of drainage area, or an average run-off of 7.6 inches.

The eastern part of the Mississippi Basin lies almost entirely in the central lowland province, though it also includes the western slopes of the Appalachian Plateau.

Here run-off increases rather uniformly across the Ohio Basin, reaching 20 inches in the eastern part of the lowlands, 25 inches in the West Virginia highlands, and 45 inches (3.3 cubic feet per second per square mile) on the Carolina-Georgia border.

It is largely because of this high yield that the Ohio River contributes so great a part of the flow in the Mississippi River. The mean annual run-off of the Ohio at its mouth is 300,000 cubic feet per second, or nearly half the total flow of the Mississippi. This is equal to an average flow of 21 inches (1.5 cubic feet per second per square mile), or almost three times the average rate of flow for the entire Mississippi Basin. The Ohio River also contributes heavily to the flood flow of the main river, the maximum recorded peak being 1,500,000 cubic feet per second. In fact great floods on the Ohio are the chief contributors to great floods on the lower Mississippi.

Great Lakes, St. Lawrence, and Red River Drainage

The streams flowing into the Great Lakes are all comparatively small, but they are extremely varied in their run-off characteristics. The Kalamazoo, Mainstee, and Au Sable Rivers in Michigan have large ground-water storage resulting in remarkably small stream variation throughout the year. The average yearly flows are from 10 to 15 inches (0.73 to 1.1 cubic feet per second per square mile). The Genesee River in New York is of an opposite type, with limited ground and surface storage, resulting in a highly variable flow of from 18 to 44,400 cubic feet per second, with average yearly run-off of from 10 to 15 inches (0.73 to 1.1 cubic feet per second per square mile). The Oneida, Seneca, and Saranac Rivers represent a type with much natural lake storage and limited ground storage, resulting in a comparatively steady regimen. Run-off on these streams varies from 15 to 20 inches (1.1 to 1.4 cubic feet per second per square mile). The Black, Salmon, Raquette, and St. Regis Rivers in New York represent mountain-type streams, where a large amount of natural surface and ground water storage, combined with high rainfall, results in heavy run-off and a fairly uniform regimen. Reservoirs have been constructed on these streams, increasing still further the regularity of their flow. Yearly run-off in the Adirondack streams averages from 25 to 40 inches (1.8 to 2.9 cubic feet per second per square mile), whereas those originating in the Green Mountains have only about 20 to 30 inches (1.4 to 2.2 cubic feet per second per square mile).

The Great Lakes are the largest bodies of fresh water in the United States; their combined area of 95,088 square miles nearly equals the land area, 115,000 square miles, of the lands in the United States that drain into them. Niagara Falls, between Lake Erie and Lake Ontario, present one of the more magnificent and inspiring sights in the country. The natural flow of the Niagara River at the falls has been reduced by 56,000 cubic feet per second diverted for power production. Recent recession of the falls has developed a condition where a large portion of the flow passes through a narrow channel, this greatly depleting the flow of water over the major falls and reducing their scenic value. Plans have been perfected whereby the falls may be protected, increased diversions permitted, and scenic values enhanced.

The St. Lawrence River has a large and regulated flow ranging from a minimum of 175,000 cubic feet per second to a maximum of 318,000 cubic feet per second and a mean flow of 246,000 cubic feet per second. This flow, together with the large and concentrated falls in the international rapids section, affords unusual opportunities for power development such as contemplated under the provisions of the treaty recently negotiated with Canada.

The Red River of the North is one of the few streams in the United States flowing north. The largest annual flow occurs in those branches rising in the eastern part of the basin, where a mean annual run-off of 2.6 inches

NATIONAL RESOURCES BOARD
WATER RESOURCES SECTION
LOCATION OF
ACTIVE STREAM GAGING STATIONS
AS OF
SEPTEMBER, 1933
Scale 1:18,750,000
100 0 100 200 300 400 500 600 Miles

(0.19 cubic feet per second per square mile) is found in the Red Lake River. Rivers on the western slopes of the basin have a much lower run-off, reaching a value of 0.5 inches (0.04 cubic feet per second per square mile) on the Pembina River.

North Atlantic Drainage

The eight principal river basins comprising this district are the Penobscot, Kennebec, Androscoggin, Merrimac, and Connecticut Rivers in New England, and the Hudson, Delaware, and Susquehanna Rivers in the Middle Atlantic States. Mean yearly run-off for the district varies from about 35 inches (2.5 cubic feet per second per square mile) in the higher reaches of the White, Green, and Adirondack Mountains, to less than 15 inches (1.1 cubic feet per second per square mile) in northwestern Maine and central New York.

The abundance of natural and artificial storage in Maine has resulted in highly regulated flows in its rivers. The Presumpscot River, for many years one of the most closely regulated streams in the country, with a mean annual flow of 20 inches (1.45 cubic feet per second per square mile), has a practically constant discharge throughout the year due to the 490 acre-feet per square mile storage, mainly in Sebago Lake.

Artificial storage on the upper reaches of the Connecticut and Hudson Rivers has made tremendous changes in the characteristics of these streams. Noteworthy are: (1) the Deerfield River, naturally a flashy stream, caused virtually no damage during the disastrous floods of 1927, while havoc was wrought on nearby streams; and (2) the Hudson River, where the construction of the Sacandaga Reservoir with 690,000 acre-feet of storage, has resulted in raising the low flows in the lower river from 1,000 to 3,000 cubic feet per second. The flows of the Delaware and Susquehanna Rivers have not yet been regulated much by storage.

South Atlantic and Eastern Gulf Drainage

Approximately two-thirds of the land area of this region is relatively level coastal plain, in which the streams giving local drainage for the 45 to 60 inches of annual rainfall are consequently sluggish and relatively uniform in flow. The annual run-off is less than would be expected from the high rainfall, ranging quite generally from 10 to 20 inches (0.73 to 1.4 cubic feet per second per square mile). The rolling clay lands of the broad Piedmont Plateau form about seven-tenths of the upland area. Here the relatively lower annual rainfall (45 inches), much of it in local showers, and the meager ground storage tends to flashy stream flow in small areas, but the areal distribution of showers over the fan-shaped basins operates to smooth out the flow of the larger streams. Run-off varies from 18 to 30 inches (1.3 to 2.2 cubic feet per second per square mile).

The Blue Ridge Mountains, containing a small percentage of the headwaters, have high annual rainfall reaching more than 70 inches in parts of western North Carolina, with limited ground storage. The run-off, in keeping with the rainfall, is high but flashy, amounting to as much as 45 inches (3.3 cubic feet per second per square mile) in some areas. The Valley and Ridge province, west of the Blue Ridge, has lower precipitation and larger ground storage than the mountains, but the narrow trough-shaped valleys produce quick, flashy run-off. The run-off characteristics at any particular point, therefore, vary according to the basin characteristics, as noted above.

The Potomac, James, and Roanoke Rivers head in the Valley and Ridge province and cut eastward through the Blue Ridge, with decreasing areas of Valley drainage and increasing areas of Piedmont drainage. The Peedee, Santee, Savannah, and Apalachicola head in the Blue Ridge, with approximately equal lengths in the Piedmont, and increasing lengths in the Coastal Plain in the order named. The Coosa, an important tributary of the Alabama River, has a large headwaters drainage with high annual rainfall in the lower end of the Valley and Ridge province and crosses the Piedmont Plateau, thereby having exceptionally valuable flow characteristics. West of this the larger streams lie almost entirely in Coastal Plain territory.

As shown by hydrographs on the map showing Characteristics of Run-off, typical streams have the following run-off characteristics near their transition from Piedmont to Coastal Plain:

River and station	Years of record	Average discharge for period of record		Ratio to average discharge represented by —	
		Inches on drainage area	Cubic feet per second per square mile	Maximum year	Minimum year
Potomac River, Point of Rocks, Md.	1895–1933	13	0.98	1.62	0.52
Santee River, Ferguson, S. C.	1907–33	17	1.29	1.60	.59
Alabama River, Selma, Ala.	1929–33	22	1.62	1.60	.49

Collection of Basic Data

Run-off data are collected at gaging stations located at strategic points on streams throughout the country. Most of these are operated, and the records compiled and published, by the United States Geological Survey. A glance at the map showing the location of nearly 3,000 active gaging stations might lead one to believe that no more were needed. However, the regional water consultants and hydraulic engineers generally are

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unanimous in the statement that the provision of basic information on stream flow necessary to plan for the highest and most effective uses of both water and land requires the establishment of at least 10 percent more stations.

Table 1 shows the distribution of stream-gaging stations operated by Federal agencies only. From this table and from the map it is apparent that in certain sections of the country additional stream-gaging stations are needed. These should be located at points where resulting data will serve the purposes of comprehensive planning and effective development.

The question of financing stream-gaging operations is important. The basic principle of action has been a 50-50 contribution by the Federal Government on the one hand and by State or local governmental agencies on the other.

Greatly curtailed State budgets have given rise to serious concern over the imminent possibility that a considerable number of valuable stations may have to be abandoned. Since a record for 10 years or less is of questionable value in determining run-off characteristics, and one that covers 40 to 50 years is required before a real approach to adequate knowledge is attained, consideration should be given promptly to methods whereby the Federal Government may completely underwrite the operation of many important basic flow stations, lest the value of the records be greatly impaired by even a short interruption of their continuous operation.

Much improvement is possible in the method of publishing stream-flow data, to make it more usable and more clearly complete. More effective cooperation between public and private agencies with regard to the collection, compilation, and publication of this data is desirable.

TABLE 1.—*Number of stream-gaging stations in active operation by Federal agencies, September 1933*

Region	Number of stations			Area	Total number of stations per 1,000 square miles
	Geological Survey	Corps of Engineers	Total		
1. North Pacific	584		584	270,000	2.16
2. South Pacific and Great Basin	431		431	300,000	1.44
3. Colorado	122		122	245,000	.5
4. Western Gulf	150		150	310,000	.48
5. Southwest Mississippi	89		89	280,000	.316
6. Missouri	311		311	520,000	.6
7. Upper Mississippi	154	2	156	190,000	.82
8. Alluvial Mississippi	31	17	48	47,000	1.02
9. Ohio	333		333	204,000	1.63
10. Red River and Great Lakes	187		187	240,000	.78
11. North Atlantic	309		309	130,000	2.37
12. Eastern Gulf and South Atlantic	245		245	290,000	.842
Total	2,954	19	2,973	3,026,000	.98

SECTION II
III. GROUND WATER

Approximately half the people of the United States use water from wells. Millions of animals, millions of tilled acres, and thousands of industrial plants likewise depend for water, wholly or in part, on underground supplies tapped by wells. Ground water is, indeed, a resource even more important than surface water over much of the country.

In various ways ground-water conditions have been affected adversely by human action in most sections of the country. Thus in some cases the replacement of prairies and forests by tilled fields and the drainage of wet lands have helped to lower the water table disadvantageously. Water has been wasted needlessly in enormous quantities from both flowing wells and pumped wells, though in many localities such waste diminishes seriously a limited supply accumulated slowly through ages. Crank-case oil from garages and filling stations, garbage from towns, refuse from manufacturing plants, and many other kinds of waste material may pollute ground waters in certain localities throughout the country. Contamination of ground water by sewage is a serious public health menace to be carefully guarded against in both rural and urban regions where such waters are used for domestic purposes.

Unnecessary depletion and pollution of ground waters should cease. So far as practicable, the principles of equitable appropriation and beneficial use should be applied to them no less than to surface waters. Their conservation, heretofore neglected in large measure, is essential to the public welfare.

I. Supplies and Occurrence of Ground Water in Different Regions

The amount, occurrence, and availability of ground water depend chiefly on climate, topography, the character and structure of the soil and rock, and the vegetal cover. The amount of ground water in general is great where rainfall is great, though water entering the ground in one place may flow underground to another. The United States may be divided into two ground-water zones corresponding to the humid and arid zones. These may be separated by the line of 20 inches of annual rainfall, which follows approximately the one-hundredth meridian and divides the country into two nearly equal parts.

The quality of ground waters varies in general with the quantity. Where abundant they are commonly potable; where sparse, highly mineralized. Shallow mantle-rock waters are usually of better quality than deeper bedrock waters, having had less contact with mineral matter beneath the surface. Most deep artesian waters are highly mineralized. Shallow waters are more commonly polluted, however, from surface contamination and organic matter.

1. The ground-water supplies of the *Pacific Northwest region* are of importance in rural localities and certain cities, such as Spokane and Tacoma.

In the *Pacific and Rocky Mountain provinces*, because of heavy rainfall, much ground water is stored in the unconsolidated alluvial deposits in large valleys. Indications are that irrigation water may be developed in the Willamette, Little Bitter Root, and other valleys. Springs are the chief source of ground-water supply in the mountains which are composed of a great variety of rocks in highly varied structure.

The *Columbia Plateau province* is characterized by thick, roughly horizontal volcanic rocks of great extent, interbedded in places with sedimentary rocks. Many of the lavas are highly porous. Rain waters and seepage from streams enter the ground and percolate to relatively impervious beds, resulting in an abundant supply of ground water. The availability of this water depends on local geologic and topographic conditions.

2a. The *Southern Pacific region* is characterized by exceedingly varied topography and geologic structure and by similarly varied rainfall and ground-water supplies. The mountainous character of the northern and west central portions of the region is such that only locally is ground water available from wells. In the southern portion, great quantities of water are stored in thick alluvial fans and cones of coarse material that cover large areas among the piedmont plains. The annual yield of ground water is about 650,000 acre-feet. Without the use of ground water in southern California, the present intensive development of irrigation there would have been impossible.

Large natural storage reservoirs are found in the waste-filled valleys of the Sacramento and San Joaquin Rivers. Run-off from the adjacent mountains and excess irrigation water, entering the porous deposits

on the valley floors, provide the only dependable water supply in a region of extremely variable precipitation. Overdraft from year to year in the Santa Clara Valley has caused a serious lowering of groundwater levels there.

2b. In the *Great Basin*, most of which is exceedingly arid, the supply of ground water is small and its utilization restricted. There are, however, many small, waste-filled valleys where contributions to the supply of ground water are made by the infiltration of surface run-off from adjacent mountain areas and of rain falling directly on the valley floors, and by underflow from tributary canyons. There is urgent need for locating, if possible, more subsurface water than can be pumped economically for livestock.

3. The scarcity of rainfall and of surface water in the *Colorado River Basin* gives to ground water, where the latter is available, a peculiar economic importance. For the most part, the basin is a plateau underlain by hard sedimentary rocks, with some lava flows. A few deep wells yield water of fair quality, but many wells have yielded bad water or have proved to be dry holes. Small springs and shallow dug wells are the chief sources of supply. The best of the latter are in valley alluvium. Cisterns are used to collect rain water and early spring run-off, which are utilized for domestic purposes in preference to the alkaline ground waters. Practically no well waters are used for irrigation, except in the Gila and Salt River Valleys.

4. Throughout most of the *Southwest Gulf region* water may be found at depths of less than 200 feet near the coast and at less than 2,000 feet farther inland. Some of it is under sufficient artesian pressure to flow, and much has been wasted needlessly.

Most of the water-bearing strata of the region consist of fine sand or porous sandstone. In places, as near San Antonio, water is found in fissures in limestone strata. Again, several of the larger cities secure water from the coarser beds of sand and gravel in the alluvial valleys. Irrigation and stock require much of the ground water that is utilized.

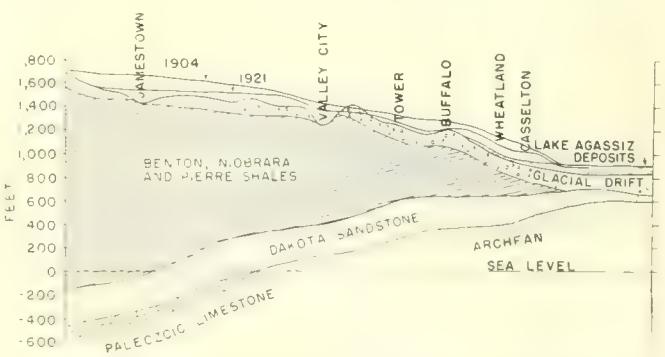
5. In the *southwestern Mississippi Basins* the residual soils of the upland plains are everywhere underlain by nearly horizontal sedimentary rocks. Throughout parts of Arkansas, Oklahoma, and Texas the predominant shales and the sandstones interbedded with them furnish supplies that are meagre and highly mineralized. In some districts widespread sandstones provide moderately abundant supplies. However, certain of the fresh-water horizons and large quantities of surface waters have been rendered unfit for domestic use by brine that has been allowed to escape from deep water wells and oil wells. Some hard water may be found in the crevices and caverns of the limestones. In general, farm wells obtain supplies at less than 200 feet, some of which are under artesian head. The most important water-bearing horizon for large municipal supplies is the alluvium in the wide valleys, especially in the more densely populated eastern part of the region.

Alluvial deposits are also the chief sources of domestic supply in the Ouchita Mountains. In this area many excellent springs flow from outcrops of novaculite, and most wells drilled in the steeply folded sandstones and shales encounter small artesian flows.

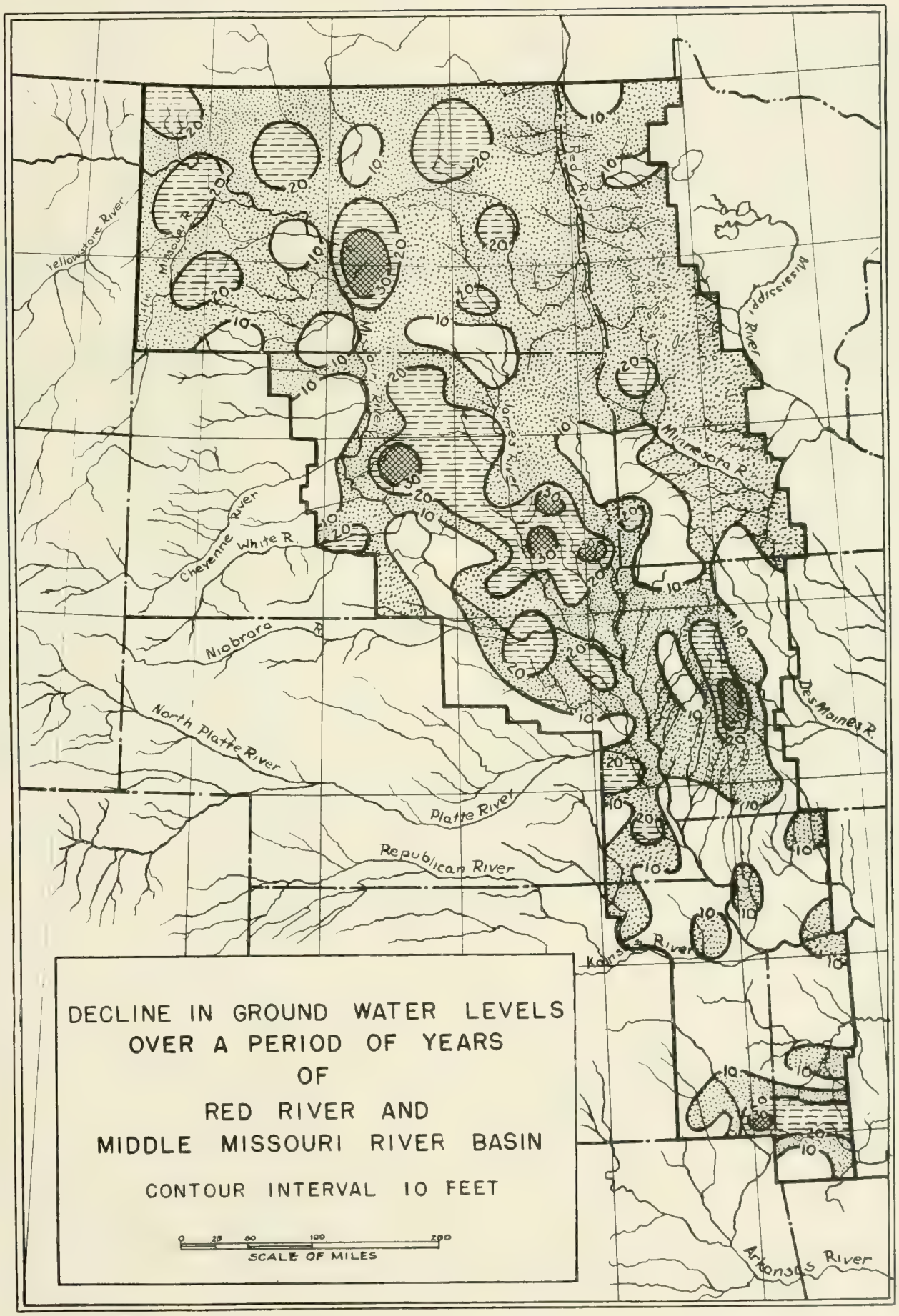
6. In the *Missouri Basin*, the steeply dipping strata of the northern Rocky Mountains contain 50 or more water-bearing horizons of varying distribution and depth. Springs, some with large flows, are a common source of water supply.

The remainder of the basin, excluding the Ozark Highland, is underlain by nearly horizontal sedimentary formations. The sandstones which occur at intervals contain most of the ground waters. Where these are lacking, as in southern Iowa, northern Missouri, and northeastern Kansas, the major potable ground waters are found in the surficial glacial drift, which in that area is thin. In some parts of the Great Plains where impervious shales are the chief surface formation, and notably in western South Dakota, the sandstone supplies are too deep or too highly mineralized for human use. In the eastern Dakotas, the Dakota sandstones are tapped by thousands of flowing wells, but wasteful use has greatly reduced their flow, and several States have enacted statutes to control these wells.

Most of the farms and ranches in the northern part of the basin depend on wells drilled a short distance into bedrock or on shallow wells sunk in glacial drift. In the southern and central portions, wells in valley alluvium are the chief sources of supply. Long periods of deficient precipitation or excessive pumpage cause a recession of the water level in these shallow wells and serious inconvenience to the rural population. The economic consequences of recession have been especially serious, of course, in those areas not having reserves in deep-lying aquifers that have been tapped by wells.



SECTION ACROSS THE DAKOTA AREA OF ARTESIAN FLOW ALONG THE NORTHERN PACIFIC RAILWAY, SHOWING HYDRAULIC PROFILES, OR HEIGHT TO WHICH THE ARTESIAN WATER WOULD RISE, ABOUT 1904 AND 1921



Prepared by H. E. Simpson

7. The northern Minnesota and Wisconsin portion of the *Upper Mississippi Basin* is an area of crystalline rocks overlain by more or less glacial drift. The yield of water from the drift and from the crevices and joints in the impermeable bedrock is small, but the quality is excellent.

In the area of drift-covered sedimentary rocks to the south, the glacial mantle is an important source of water for rural uses. Much of the shallow water is hard, however, and is subject to pronounced fluctuations in level. Large drafts for urban use are made on the glacial outwash sands and gravels, particularly on those in certain preglacial valleys. The distribution of such depressions, furnishing storage in the surface of the bedrock, is not known in many parts of the region. Some of the underlying sandstones contain artesian supplies which serve numerous municipalities, but most of the deeper water is more or less mineralized.

8. Beneath the *Alluvial Mississippi Basin* there is a great trough of sedimentary rocks, covered with alluvium, which contain very abundant quantities of potable water at depths of from 100 to 1,500 feet. The water table is near the surface in the alluvial valley, but the ease with which the upper ground waters are polluted and the presence of obnoxious vegetal matter in the alluvium render most supplies from shallow wells unsatisfactory. Such supplies are in general use, however, in the rural areas of the lowlands. The supply from shallow wells in the uplands is of better quality.

9. The *Ohio Basin* is underlain by hard sedimentary rocks which are mantled with glacial drift in most parts of the drainage area north of the Ohio River. Deep wells tap many parts of the sandstone, and also the cavernous limestone and dolomitic acquifers. In the glaciated areas, the drift is a major source of water for rural consumption, while alluvial deposits and sedimentary rocks furnish meager to moderate supplies of ground water in the southern part of the basin. Throughout most of the basin the water is hard, and in many areas it is highly mineralized.

GENERALIZED SECTION ACROSS NEW JERSEY FROM PHILADELPHIA TO ATLANTIC CITY
SHOWING GROUND WATER HORIZONS
(MODIFIED FROM THOMPSON)

10. The *Great Lakes Basin* is almost everywhere favored with adequate supplies of shallow ground water which occur in lacustrine deposits, glacial drift, or sedimentary bedrock.

In the southern Peninsula of Michigan a saucer-like structure of the bedrock yields many flowing wells and, in some valleys, strong artesian springs. Glacial deposits also afford artesian aquifers in restricted areas.

In the *Red River Valley* water is obtained from shallow wells in beach and delta deposits and in lake silts, and from tubular and artesian wells in the drift and sedimentary bedrock (p. 309). The shallow sand and gravel waters are of good quality in most places, but are not abundant. The waters of clayey lake deposits are typically alkaline and the deeper artesian waters are saline. The shallow waters have been greatly depleted by drought, and the artesian waters by waste.

11. In the *North Atlantic region* ground water is abundant; it affords domestic supplies for approxi-

GENERALIZED GEOLOGIC SECTION

OF THE

MISSISSIPPI RIVER BASIN

SHOWING WATER-BEARING HORIZONS

CENOZOIC	QUATERNARY	Recent	Dune Sand and Loess	Provides small domestic wells.
			Alluvium	Yields good shallow domestic supplies locally and some large city supplies in alluvial valleys, Lower Miss. Basin.
		Pleistocene	Glacial	Excellent shallow aquifers in course sand and gravel beds. Many wells in drift dry during drought, deep wells in outwash filled valleys yield large supplies of excellent water.
	TERTIARY		Pliocene	Sands and gravels, lignities, and scoriaceous clays of these formations yield reliable supplies. Examples: Fort Union (Eocene)-Upper Missouri; Ogallala (Pliocene) Gehring and Arikee (Miocene)-Lower Missouri; and the Claiborne and Wilcox (Eocene)-Lower Mississippi.
			Miocene	
			Oligocene	
			Eocene	
MESOZOIC	CRETACEOUS		Lance	Thin sandstone layers yield local supplies in Lower Missouri Basin.
		Upper Cretaceous	Laramie	Sandstone layers and lenses yield water locally.
			Fox Hills	
			Pierre	Unimportant—mostly dry shales. Sandstone layers near outcrops yield water.
			Niobrara	
			Benton	
			Dakota	One of best aquifers in Basin. Large supplies (many artesian) obtained in sandstone. Usually somewhat saline except near outcrops.
		Lower Cretaceous		Locally called Comanche in Gulf Region. Saline water is found in thin sandstone layers.
	JURASSIC			Composed of alternating layers of thick shale, thin limestones, sandstones, and coals of Permian and Pennsylvanian. These horizons furnish small farms and household supplies in Upper limestone and sandstones. Large supplies are obtained in southern Illinois in basal water bearing sandstones.
	TRIASSIC			
PALEOZOIC	PERMIAN			
	PENNSYLVANIAN			
	MISSISSIPPIAN			Farm and domestic supplies and sometimes large supplies of hardwater are obtained from solution cavities and joints at depths of less than 300 feet.
	SILURIAN			
	DEVONIAN			
	ORDOVICIAN			St. Peter, Jordan, New Richmond and Dresbach sandstones, near outcrops yield abundant fresh water to shallow wells; deeper artesians in Upper Mississippi Basin yield strong flows of mineralized water.
	CAMBRIAN			
PRE-CAMBRIAN				Unimportant. Some water obtained at less than 200 feet in joints and crevices.

Prepared by H. E. Simpson

mately 6 million people and is used also by many industries.

North and west of New York City an incomplete mantle of glacial drift yields water for farms, villages, cities, and industries. Throughout most of this area dense crystalline rocks, in which water occurs sparingly in joints, underlie the drift.

Beneath the Coastal Plain large amounts of water, commonly used for all domestic purposes, occur in beds of sand and gravel which alternate with beds of clay in seaward dipping formations. Much of this water is artesian, and great care is needed to avoid contamination of the supply by salt. These conditions are well illustrated by a section of the Coastal Plain between Philadelphia and Atlantic City. In the northern, glaciated portion of the Coastal Plain, except in the burroughs of Brooklyn and Queens, in New York City, practically all supplies of water are from underground sources, chiefly the drift. Much larger supplies can be developed, though care is needed to avoid salt water.

12. Heavy rainfall helps to provide an abundant supply of shallow ground water in the *South Atlantic and Eastern Gulf Region*. The permeable, deep soils overlying in most places the upturned sedimentary strata of the ridges and valleys favor infiltration. Large springs occur in cavernous limestone, and the few deep wells that are needed furnish an ample supply. The crystalline bedrock of the Blue Ridge and piedmont are highly impervious and in those areas ground water is found chiefly in the zone of partial decomposition between bedrock and the stiff clayey residual soil. Small springs and shallow wells are numerous; deep wells yield small supplies from fissures in bedrock. The porous, nearly horizontal sedimentary rocks of the Coastal Plain store abundant water at shallow depths, depths that are too shallow near the coast, where the water contains much organic matter. Deep bedrock water under slight artesian head also is abundant. The quality is good except where the supply has been overdrawn and salt water has entered. Extensive artesian irrigation is practiced in Florida.

II. Generalizations

1. Water, not soil, is the resource that ultimately will limit the productive capacity of the lands of the United States, viewed as a whole. Even now, the further development of large areas depends in considerable part on the extent to which available supplies of ground and surface waters are conserved.

2. Since ground water and surface water are related so closely in origin, use, and administration (actual or desirable), it is essential in many connections to consider them together, as a common resource. Aside from their occurrence, the one in the ground and the other on the ground, they are fundamentally alike, each becoming the other.

3. Further factual surveys and investigations of ground water resources are an indispensable prerequisite to their proper administration, equitable allocation, and more efficient utilization. The wide range in the character of the requisite studies is suggested by the pressing need for the determination, among other things, of (1) the extent, depth, thickness, water content, sources of supply, and rates of replenishment of the principal ground water horizons; (2) the types of wells best suited to the various aquifers; (3) the best placement of wells in critical areas to avoid the pollution of their waters, and to promote the most effective utilization of the available supplies of water; (4) variations in the level of the water table in each distinctive ground water area, by measurement at regular intervals through the years of the height of the water in properly selected wells; and (5) the relation of pond storage, of reservoir storage, and of irrigation (project irrigation and supplemental irrigation) to the replenishment of ground water and the accumulation by it of deleterious or beneficial substances in the soil.

4. The fundamental concern of the Nation in ground water resources, a concern certain to increase with passing years, indicates the need of a broad, comprehensive, and more definite national policy with respect to them, particularly from the standpoint of their varied interstate relationships.

SECTION II

IV. THE QUALITY OF SURFACE AND GROUND WATER IN THE UNITED STATES

By Sheppard T. Powell

The Problem

A study of the quality of water centers around two fundamental considerations: (1) dissolved or suspended mineral matter, and (2) dissolved or suspended organic matter. The presence of various substances which fall under these two classifications may be a function of the natural environment of the water, or may be introduced as pollution from extraneous sources.

Dissolved mineral matter seldom affects the potability of water. However, for other domestic uses and for many industrial uses it is a serious factor,as bill we shown. Hardness, which is the best general index of the quality of water as it is affected by dissolved mineral matter, represents essentially the carbonates and sulphates of lime and magnesium. These substances consume soap, deposit as boiler scale, and otherwise render water undesirable for domestic and industrial use.

Dissolved Mineral Matter

Hardness: The amount of hardness which can be tolerated varies, of course, with its use. Waters with a hardness of 0 to 60 parts per million need not be softened for domestic use and present a small problem to make them suitable for industrial use. Those with a hardness of 60 to 120 parts per million can be softened at a moderate expense. When the hardness ranges from 120 to 180 parts per million, however, water softening becomes a major operation approaching prohibitive expense at the upper limits for industries requiring a relatively soft water.

Figures 1 and 2 are maps showing the average hardness of public and private surface water and ground water supplies, respectively. It will be seen that the north and south Atlantic and north Pacific drainage basins are favored with soft surface water. The observation may be made at this point that in the north Atlantic region where this condition obtains and where the supply available is also generous and widely distributed, we find the highest concentration of industries. It will be noted in figure 2 that the ground water over most of these areas is also of a hardness below 120 parts per million, with the notable exception of Long Island, a portion of New York and New Jersey, and in part the Appalachian region and the Florida peninsula.

The surface waters of the Ohio Valley and Great Lakes drainage basins are moderately to excessively hard, increasing toward the north, while the ground waters generally have a hardness above 180 parts per million.

Both the surface and ground supplies of the Missouri and the northern and southern Mississippi basins range from 60 to 120 parts of hardness in the south, to extremely hard water in the north. Sources of soft water, which characterize the south Atlantic basin, appear occasionally in the southern Mississippi and the western Gulf of Mexico regions.

Underground water accounts for more than half of the supply of the States surrounding the Gulf of Mexico. A region of scarce and very hard water extends from the Mohave Desert, through the Colorado Basin, into the western Rio Grande Valley.

The surface waters of the Pacific coast are reasonably soft in the upper valleys, with increasing hardness toward the coast. Underground supplies of considerable hardness serve about 70 percent of the population in this region.

Attention is called to the large areas, including important sections of the country, which on the maps are blank because insufficient data are available. It is highly desirable that Federal and State agencies rectify this deficiency by the prompt inauguration of comprehensive water quality investigations.

Dissolved Iron and Manganese: Undesirable constituents of water other than those that constitute hardness are iron and manganese. If these are present above a certain concentration, they are deposited from the water when its physical or chemical condition is changed. Their complete removal is necessary for many industries. Figure 3 shows the distribution of iron-bearing ground waters and it will be seen that they are widely scattered throughout the United States. Manganese is present in substantial quantities in the surface waters of North Carolina and West Virginia, the ground waters of Texas and Massachusetts, and both the surface and ground waters of Illinois and Pennsylvania. This is a particularly objectionable element in waters used for the textile, paper, and some other industrial processes.

Relation of Dissolved Mineral Matter to Amount of Run-off: The quality of surface waters which are subject

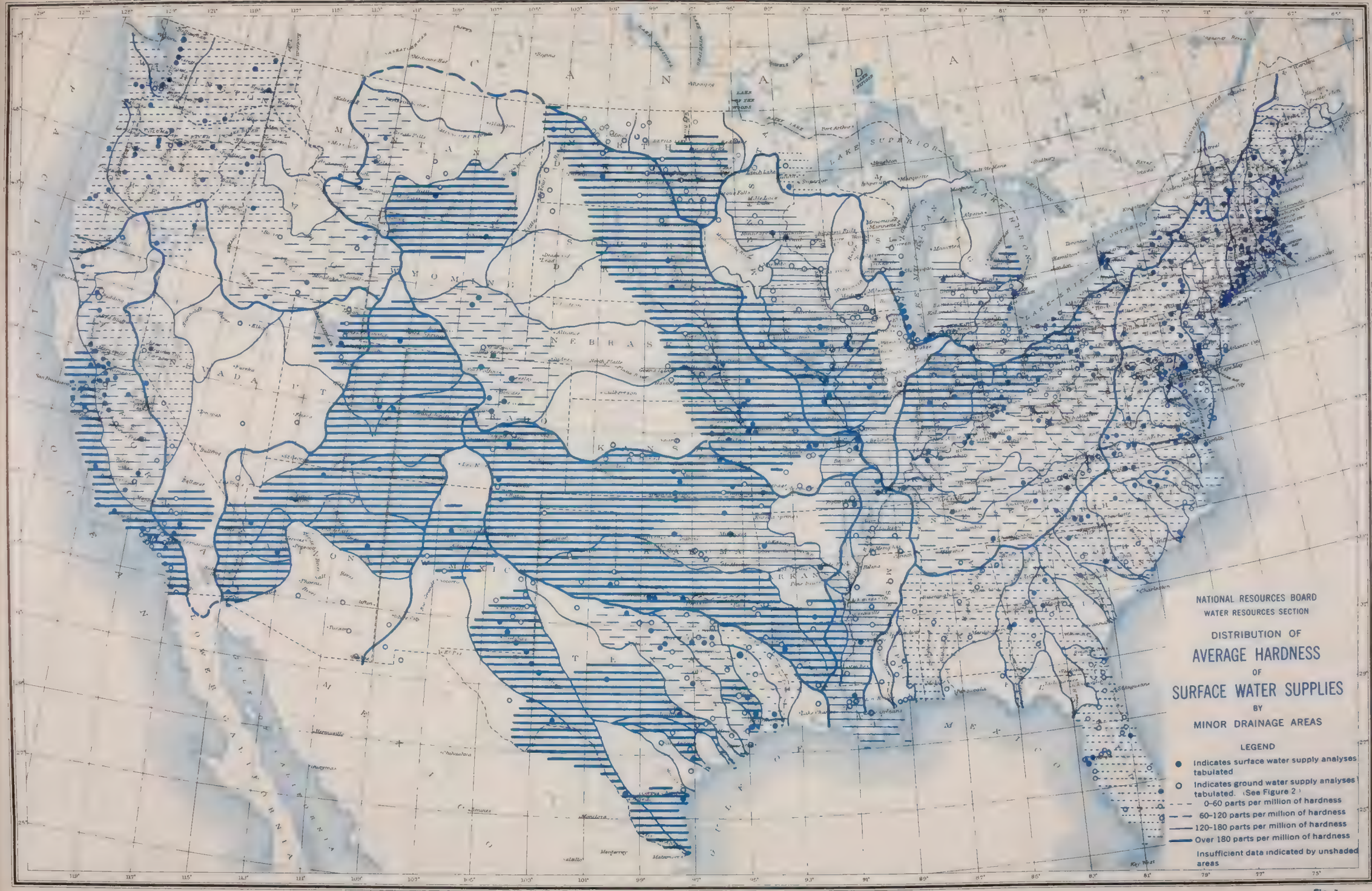

NATIONAL RESOURCES BOARD
WATER RESOURCES SECTION
DISTRIBUTION OF
AVERAGE HARDNESS
OF
SURFACE WATER SUPPLIES
BY
MINOR DRAINAGE AREAS
LEGEND
Indicates surface water supply analyses tabulated
Indicates ground water supply analyses tabulated. (See Figure 2)
0–60 parts per million of hardness
60–120 parts per million of hardness
120–180 parts per million of hardness
Over 180 parts per million of hardness
Insufficient data indicated by unshaded areas
Scale 1:8500000
100 0 100 200 300 400 500 600 Miles

Fig. 1

NATIONAL RESOURCES BOARD
WATER RESOURCES SECTION
DISTRIBUTION OF
AVERAGE HARDNESS
OF
GROUND WATER SUPPLIES
BY
MINOR DRAINAGE AREAS
LEGEND
Indicates surface water supply analyses tabulated (see figure 1)
Indicates ground water supply analyses tabulated
0-60 parts per million of hardness
60-120 parts per million of hardness
120-180 parts per million of hardness
Over 180 parts per million of hardness
Insufficient data indicated by unshaded areas
Scale 1:8,750,000
0 100 200 300 400 500 600 Miles

Fig. 2

NATIONAL RESOURCES BOARD
WATER RESOURCES SECTION
DISTRIBUTION OF
IRON
IN
UNDERGROUND WATERS
LEGEND
Indicates ground water supply analyses tabulated
Indicates surface water supply analyses tabulated
0.01-0.10 parts per million of iron
0.11-0.20 parts per million of iron
0.21-0.50 parts per million of iron
0.50-1.00 parts per million of iron
Over 1.00 parts per million of iron
Insufficient data indicated by unshaded areas
Scale 1:8,000,000
Miles

Fig. 3

to fluctuations in run-off is greatly depreciated during dry periods. This is shown graphically in figure 4 in which average stream flow has been plotted against average hardness, and curves drawn for five rivers. In each case low flow results in greatly increased hardness. The inland rivers (4 and 5 in fig. 4) have comparatively hard water at high-water stages, as may be expected, and at low-water stages they are exceedingly hard. This results in enormous financial losses when such waters must be treated to make them suitable for industrial uses. The data relating to these conditions are so meager that conclusions as to the economic importance of all surface waters cannot be reached at this time. To provide an illustration of the financial burden imposed on the domestic and industrial consumers, the losses sustained because of this condition in the Philadelphia area during the period from January 1929 to March 1931 have been plotted in figure 5. The year 1929 was a period of moderately high run-off and the losses are comparatively low. The late fall of 1930 was, on the other hand, a very dry period and the losses mounted accordingly. It has been estimated that the depreciated quality of the Delaware River imposed an added financial burden on water consumers in this district of at least $6,500,000 from 1929 to 1933 inclusive. Total losses including many indeterminate items are not readily calculable from the data now available, but would reach two or three times the figure quoted.

Variations in Salinity of Water: At low-water stages of certain rivers flowing into the sea, salt water backs up into the river channel for a considerable distance. Below the confluence of the Sacramento and San Joaquin Rivers in California, for example, is an area of leveed land on which this influx of salt water has had a particularly serious and deleterious effect. It has been estimated by a special investigating board that the continued invasion of salinity would damage the productivity of this land as much as 5 percent of the total acreage, equivalent to an annual crop loss of $1,500,000. In addition to this loss, it has been estimated that by adequate regulation of stream flow by the construction of reservoirs $276,000 would be saved annually in the operation of boiler feed-water treating systems, and there would be an additional saving of approximately $441,000 on reduced damage due to marine borers and to improvement in quality of municipal water supplies in this area.

The incursion of salt water into oyster-producing areas is also a matter of economic importance and, if uncontrolled, will impose large annual losses to the industry. Oysters and other shellfish are able to thrive in waters having a high range of salinity, but may be destroyed by certain marine enemies if the salinity of the water adjacent to the oyster beds exceeds a certain concentration. The objectionable enemies are the drills, starfish, mussels, and certain other forms of marine life, but these organisms cannot thrive in waters of relatively low salinity and, therefore, will not invade the oyster-growing beds if the salinity of the water can be kept within proper limits. During the drought periods of 1930 and 1931 the salt content in the Delaware River increased rapidly because of reduced run-off, causing great losses to the shellfish industry in this

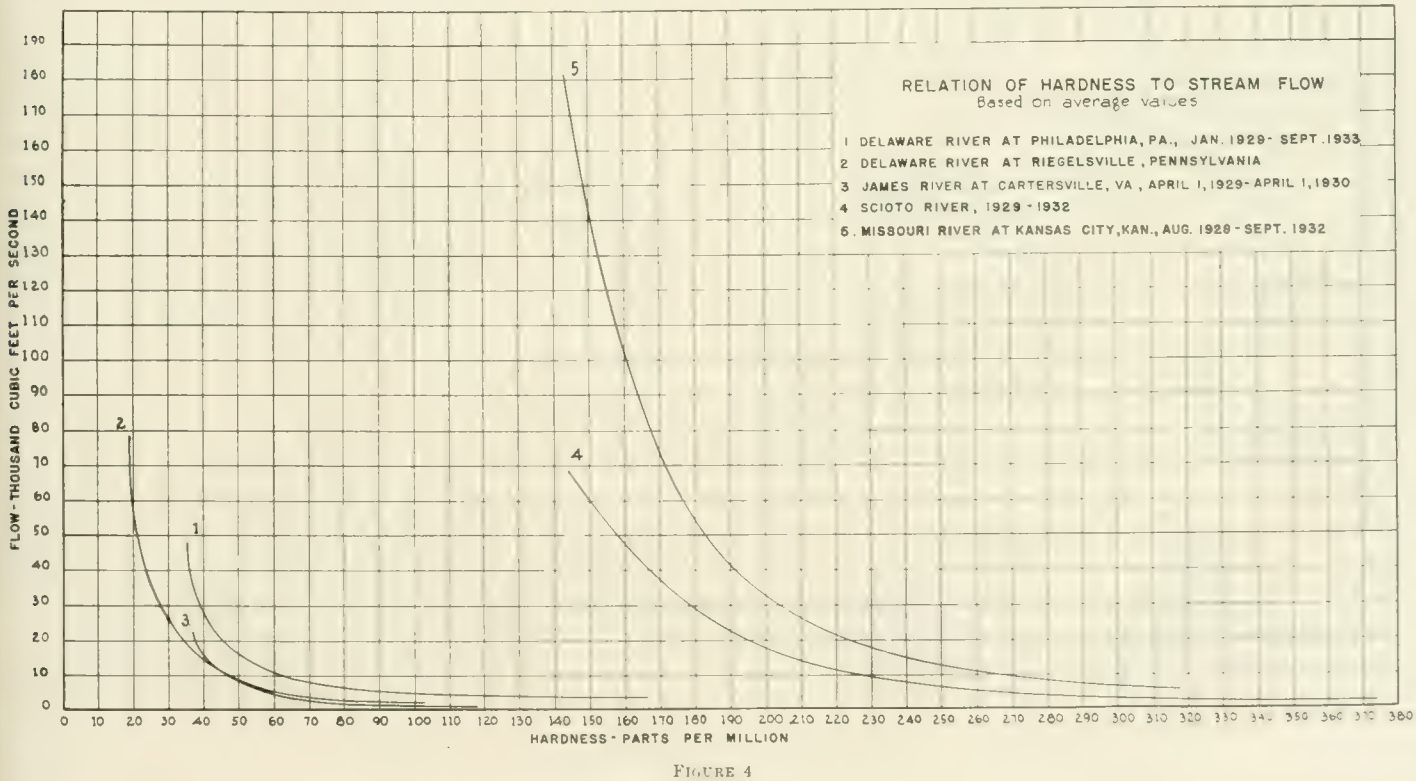

RELATION OF HARDNESS TO STREAM FLOW
Based on average values
1 DELAWARE RIVER AT PHILADELPHIA, PA., JAN. 1929 - SEPT. 1933
2 DELAWARE RIVER AT RIEGELSVILLE, PENNSYLVANIA
3 JAMES RIVER AT CARTERSVILLE, VA., APRIL 1, 1929 - APRIL 1, 1930
4 SCIOTO RIVER, 1929 - 1932
5. MISSOURI RIVER AT KANSAS CITY, KAN., AUG. 1928 - SEPT. 1932
FLOW - THOUSAND CUBIC FEET PER SECOND
HARDNESS - PARTS PER MILLION

FIGURE 4

to fluctuations in run-off is greatly depreciated during dry periods. This is shown graphically in figure 4 in which average stream flow has been plotted against average hardness, and curves drawn for five rivers. In each case low flow results in greatly increased hardness. The inland rivers (4 and 5 in fig. 4) have comparatively hard water at high-water stages, as may be expected, and at low-water stages they are exceedingly hard. This results in enormous financial losses when such waters must be treated to make them suitable for industrial uses. The data relating to these conditions are so meager that conclusions as to the economic importance of all surface waters cannot be reached at this time. To provide an illustration of the financial burden imposed on the domestic and industrial consumers, the losses sustained because of this condition in the Philadelphia area during the period from January 1929 to March 1931 have been plotted in figure 5. The year 1929 was a period of moderately high run-off and the losses are comparatively low. The late fall of 1930 was, on the other hand, a very dry period and the losses mounted accordingly. It has been estimated that the depreciated quality of the Delaware River imposed an added financial burden on water consumers in this district of at least $6,500,000 from 1929 to 1933 inclusive. Total losses including many indeterminate items are not readily calculable from the data now available, but would reach two or three times the figure quoted.

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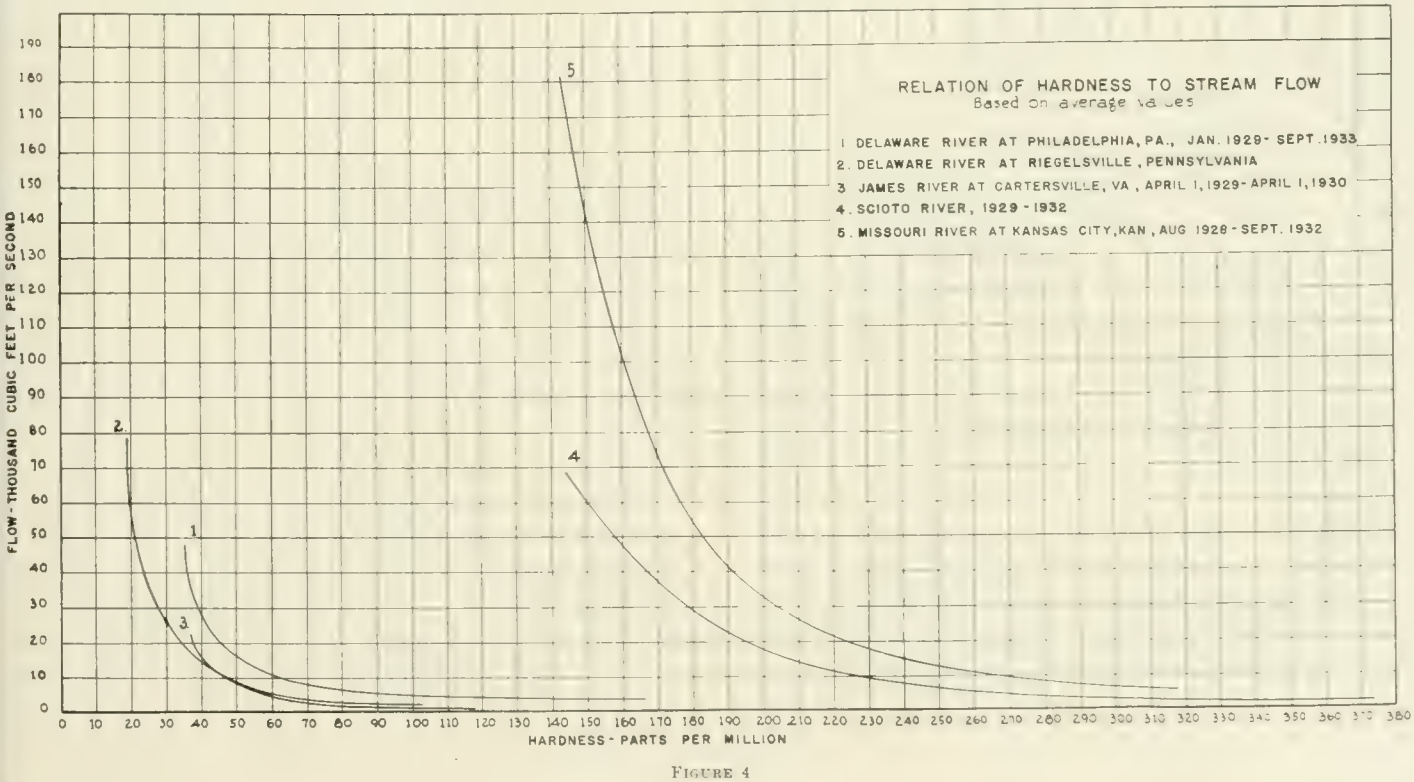
RELATION OF HARDNESS TO STREAM FLOW
Based on average values
1. DELAWARE RIVER AT PHILADELPHIA, PA., JAN. 1929 - SEPT. 1933
2. DELAWARE RIVER AT RIEGELSVILLE, PENNSYLVANIA
3. JAMES RIVER AT CARTERSVILLE, VA., APRIL 1, 1929 - APRIL 1, 1930
4. SCIOTO RIVER, 1929 - 1932
5. MISSOURI RIVER AT KANSAS CITY, KAN., AUG 1928 - SEPT. 1932
FLOW - THOUSAND CUBIC FEET PER SECOND
HARDNESS - PARTS PER MILLION

FIGURE 4

one region. It is important, therefore, that for the protection of the shellfish industry the salinity of the water in certain tidal estuaries be controlled insofar as is practicable.

Pollution

The entire subject of stream pollution is of growing importance, since in many sections of the country contamination of the water courses is causing large financial losses to consumers of water. The magnitude and diversity of these problems are increasing so rapidly in many localities that effective control and abatement of future pollution of the natural waterways is a most difficult problem. It would be misleading to indicate that the numerous regulatory boards and commissions created within the past few years for the specific purpose of controlling these problems have not made an earnest effort to cope with the situation or to presume that all such effort has been in vain. In some localities marked improvement has resulted from intelligent legislation and cooperative effort between these regulatory bodies and municipalities and industries responsible for contamination of natural waterways. Notwithstanding the intelligent and cooperative programs, industrial waste and domestic sewage problems are outstripping the best effort of those whose function it is to effect economical and rational balance between sensible regulation and industrial expansion.

The major sources of stream pollution may be classified into the following general groups: (*a*) Domestic sewage, (*b*) industrial wastes, (*c*) mine drainage, and (*d*) erosion. The relative importance of these problems varies widely in different sections of the country, but the combined results of the varying forms of stream pollution are of national importance, since they impose enormous financial and other burdens the results of which are often of a far-reaching effect.

The control of stream pollution generally comes within the scope of State or local regulation and, with the exception of the pollution of interstate streams or other waterways, such regulation is logically a State function. In its broader aspect, regulation of interstate streams ceases to be a local problem and may only be controlled by interstate compacts or by Federal regulation. In the majority of States, the existing legal authority to limit the degree of stream pollution must be exercised with rare judgment in order to prevent the stifling of industrial activity and expansion. Adequate control of stream pollution has been effected most satisfactorily in States where mutual cooperation between the regulatory body and the industries has been secured.

Industrial Waste: One of the primary causes of the existence of this great problem may be traced to the material wastes which are prevalent in almost every industry. The most urgent need at the present time is an inventory of the nature, volume, and geographical distribution of the waste products of industry as a basis for a study to determine their economic value and usability in a raw or purified state. These should be prosecuted under Federal auspices.

The present difficulties arising from industrial waste would disappear in considerable measure if the same

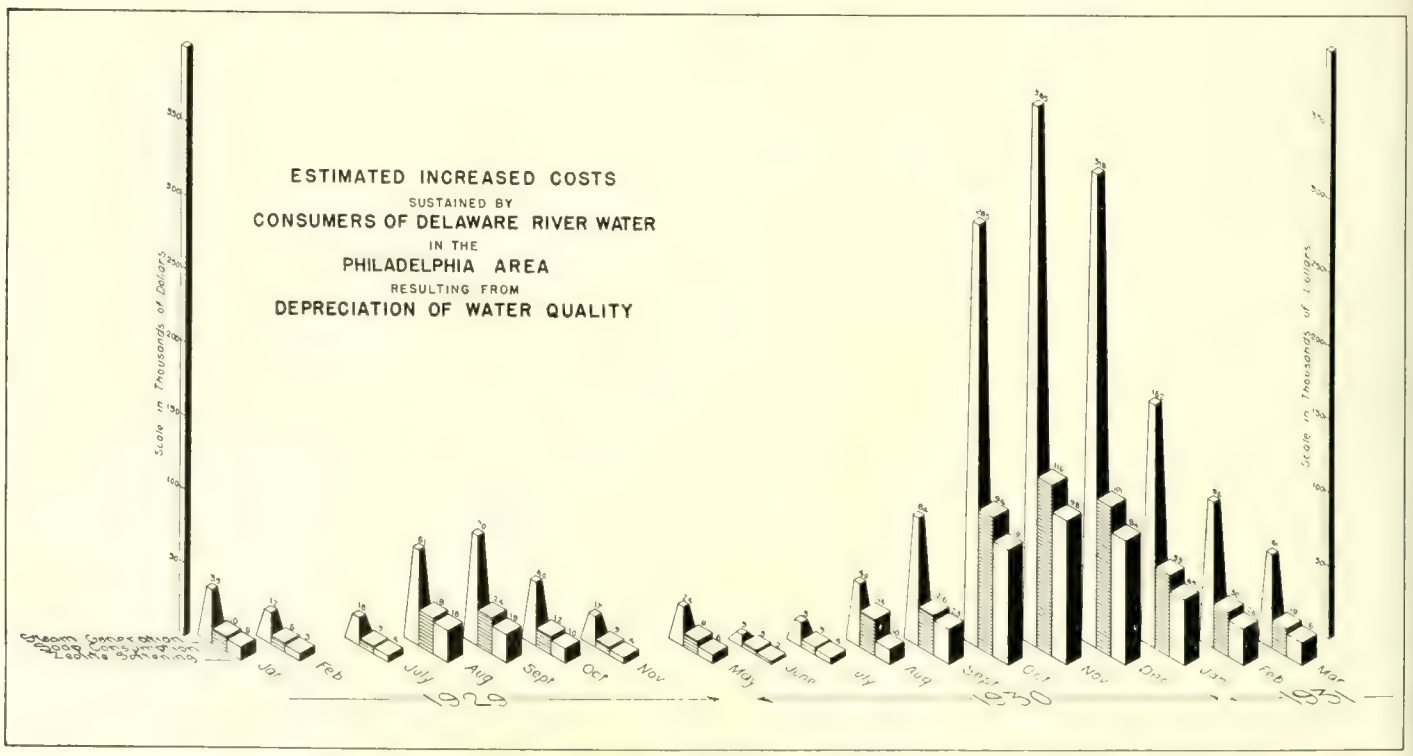

FIGURE 5

degree of research and development which has energized industries were applied to these problems. Unfortunately, the approach for relief has been directed toward correction and not prevention and, except in isolated cases, constructive research has not been the motivating force in the search for relief. Industrial waste research is often too costly for single units of industry to undertake.

There are four specific benefits which will justify Government aid to industry in the solving of these problems. They are:

(1) Alleviation of the extremely serious national problem of gross pollution of surface waters.

(2) Stimulus to business and possible creation of new industries in the conversion of present wastes into products of economic value. The prediction of such results is amply justified by recent experience. For instance, activated carbon, a valuable product, is now recovered from paper mill stock waste; and ferric sulphate, a useful coagulant for water purification, is being reclaimed from highly objectionable dye waste.

(3) Employment of technically trained men, a group which has suffered severely during the depression, and which are still in great need and are the last to feel the benefit of increasing industrial activity.

(4) Conservation of national resources by the conversion of objectionable wastes into products useful in the promotion of industry.

Although all of the desirable expenditures for research in this field may not be self-liquidating, still, in the broader sense, the ultimate results will be of this nature.

In the absence of complete data it is impossible to state the financial requirements for an adequate present attack on this problem. However, from our experience and a close study in a large group of industries, it is believed that a program embodying at least from 10 to 20 million dollars is fully justified.

Mine drainage: As an illustration of the financial burden resulting from mine drainage, it is conservatively estimated that the depreciation of the quality of water is costing the railroads running east from Pittsburgh from $12,000,000 to $20,000,000 per year, because of corrosion and scale in locomotives. A number of plans for correction of mine drainage wastes have been advanced and some improvement has resulted from cooperation between the mine operators and the States where mine drainage is serious. The magnitude of this problem is indicated by the fact that the cost of neutralizing the acid discharge into the streams of Pennsylvania would be $75,000,000 annually for the capital investment, and from $41,000,000 up annually for operation of neutralizing plants. It is recognized that neutralization of acid wastes is not a practical solution of the problem and it is probable that sealing of abandoned mines is the least expensive and the most satisfactory control method yet suggested. The expenditure of $200,000, advanced as a C. W. A. project in Pennsylvania during the winter of 1933–34, resulted in sealing 286 mines, closing 13,000 drifts, shafts, and caves, and sealing 768,000 lineal feet of crevice. This work was done on the watersheds of the Allegheny, The Monongahela, and the West Branch of the Susquehanna Rivers. While it is not possible to determine, at present, the value of this work, it is indicated that there has been a satisfactory reduction in the acidity of the streams affected. It is recommended that consideration be given to a continuation of this work as a part of any Federal program which may be developed, since it is believed that the savings resulting in improvement in water quality will justify the expenditure.

Erosion: Suspended matter in appreciable amounts cannot be tolerated by domestic and industrial consumers, and constitutes an important problem in certain sections of the country. Regions subject to serious erosion have extremely muddy surface waters. The silt content of streams is an important factor in the design and operation of purification systems, in causing loss of capacity of storage reservoirs, in detracting from the recreational uses of a stream, and may be a severe menace to fish life. The silt may retain organic pollution and bring about decomposition with objectionable and toxic products. Reduction in the silt content of streams is chiefly a matter of erosion control which has been the subject of study by various governmental agencies and is an aspect of the quality of water which warrants every effort at correction.

Relation of Concentration of Industries to Quality of Water

It is obvious that the concentration of industries in certain sections of the country may not be continued indefinitely, and some intelligent plan for the dispersion of such activities must be developed in the immediate future. Since many industries are dependent upon an adequate and chemically satisfactory water supply, any comprehensive program of industrial decentralization is intimately related both to the quantitative and qualitative nature of the water resources available. So many factors are involved in the geographical establishment of group industries that it is difficult to evaluate the importance of water resources responsible for such grouping, but water quality is as important an item in some industries as fuel or raw materials.

There is a dearth of accurate information on the economic importance of water quality and industrial expansion and development. Compilation of such data is urgently required and essential for the promotion and develpment of continued industrial growth. It is recommended, therefore, that any plan of decentral-

ization of industries include a comprehensive study of water quality, with special consideration to the economic importance of such factors.

Recapitulation

To recapitulate our findings, we are summarizing below the general conclusions reached as a result of our study, together with the indicated recommendations for the control of the quality of surface and underground waters in the United States.

1. The chemical quality of surface water is greatly depreciated during reduced stream flows and this depreciation is imposing a heavy financial burden on domestic and industrial consumers.

2. There is an appreciable influx of salt water into many of the tidal rivers during dry periods of the year. This condition is responsible for marked increase in hardness, total solids, and chlorides in the lower portions of the tidal rivers. Much difficulty is experienced in conditioning water for domestic and industrial uses and imposes heavy financial losses.

3. The main water courses, especially in the eastern and central part of the country, are subject to gross pollution in the immediate vicinity of large cities and industrial centers. Heavy industrial pollution loads from mine drainage are also contaminating surface water courses. These conditions are responsible for a large financial burden to domestic and industrial consumers of water in such districts.

4. There are large groups of industries where water is an essential factor for manufacturing uses and is responsible for the development of specific types of industries in certain localities. In any Federal program of industrial decentralization of industries, the quantity and quality of water available should be given consideration.

5. Depreciation of water quality due to drought and industrial wastes has an important bearing on the fish industry, especially shellfish. This industry is of sufficient importance in certain sections of the country to warrant an economic study of these problems of stream control in areas where such industries are established.

6. It is indicated that the chemical quality of surface water courses may be detrimentally affected by the return of irrigation waters, and a study of these conditions is warranted in order to assemble sufficient data to determine their importance and to suggest necessary regulation.

Recommendations

There is little question but that a number of the problems outlined in this chapter deserve the coordinated study which only the Federal Government can give them. The lines of attack which suggest themselves are: A coordination of the results of the agencies now engaged in the chemical analyses of water; a study of the influence of stream control and irrigation projects on the quality of water and a correlation of the data on the potential savings from such control; a study of the incursion of salt water into tidal streams as a part of flood-control measures; and a study of the advisability of Federal control of interstate waterways with special reference to domestic, industrial, and mine drainage pollution.

SECTION II
V. COASTAL EROSION AND PROTECTION

General

Attention has been directed in the section on recreation to the large and increasing use of the coastal waters of the United States as important areas which millions of people visit annually to enjoy bathing, fishing, boating, and other recreational and resort activities. Particularly along the 4,000 miles of sandy beaches comprising the Atlantic and Gulf shore line, investments totaling upward of a half billion dollars are being jeopardized, or even in part destroyed, by erosion and sand movements due to the action of waves, especially during storms. Along the New Jersey coast, which is subject to frequent storm attacks, millions of dollars' worth of property has been damaged by these forces, and more than $2,000,000 has been expended in protective measures. Only less serious, because situated in less densely populated areas, are coastal erosion problems in Massachusetts, New Hampshire, Delaware, Virginia, North Carolina, Georgia, Florida, Texas, and California. Local difficulties have also arisen on the shores of the Great Lakes. The accompanying map shows known areas of significant coastal erosion.

Erosion of sandy coasts is not a continuous or uniform phenomenon, and the causes producing it, as well as the appropriate remedial measures, vary greatly in different localities. It is estimated that in New Jersey the average erosion along the entire coast amounts to 2 feet annually, but this is a figure derived from excessive erosion of a hundred or more feet in a year at one locality and accretion of considerable amounts elsewhere. At Wrightsville Beach, N. C., along a beach 15,000 feet in length, changes between 1927 and 1930 varied from accretion of 60 feet in some places to erosion of 230 feet in others. Manifestly the design of protective structures should be predicated upon a detailed study of the numerous forces in action at different places. Inadequate protective structures, as indicated in the accompanying photographs, may not only cause large waste of public funds, but in addition may actually accelerate the processes of erosion.

The study of problems affecting the erosion of ocean beaches in this country is comparatively recent. Erosion has in the past caused the abandonment of properties situated along the ocean front and the construction of new facilities farther shoreward. This was particularly true where properties had a low valuation and where there was sufficient space available on which structures might be erected without too large an expenditure of funds. At the present time these conditions are rapidly changing. Hotels, houses, and business properties are being built and have been built along streets whose locations are permanently fixed. Property owners in the rear of the ocean front have erected expensive buildings on their holdings and it has now become impossible to allow the ocean to continue its annual erosion without a great financial loss being incurred. Available evidence indicates that the annual rate of erosion along the sandy coasts of the United States varies in general between 2 and 10 feet per year (computed by change in the location of the low-water line). This does not mean that every location suffers this erosion annually for, in fact, many locations are

Groins for beach protection at Wrightsville Beach, N. C., showing effect of inadequate length and lack of bulkhead at land end. Dane [illegible], groin [illegible] feet [illegible] three years. Left view, looking north September 1927. Right view, looking north September 1929.

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rapidly building out into the ocean. However, taking into consideration the entire length of shore line, erosion predominates over accretion along the ocean front.

Numerous foreign countries and agencies thereof have undertaken studies to prevent erosion of their shore line. There are records of villages containing considerable populations which have now entirely disappeared along the coasts of England and other countries situated along the shores of ocean waters. Similar studies have recently been made in the United States when it was seen that the problem of defending the coasts from wave attack was becoming serious. Private agencies, as well as Government agencies, have been engaged in these studies. Numerous designs for beach protection works have been proposed, some of which are entirely adequate, and others could not be expected to last for more than a few years.

In 1926, the State of New Jersey, which is seriously affected by the encroachment of the sea, invited the governors of the several States bordering the shores of the Atlantic, Gulf, Pacific, and Great Lakes, to send representatives to a convention held at Asbury Park. As a result of this convention, the American Shore and Beach Preservation Association was formed. This association has as its aim the construction, maintenance, and preservation of the natural beaches for the health and recreation of the people of the United States. The American Shore and Beach Preservation Association in turn sponsored the creation of the Beach Erosion Board under the jurisdiction of the Chief of Engineers of the Army, for the general study of problems having to do with shore protection. Numerous States have organized commissions, boards, etc., for the study of problems of erosion affecting the States alone, namely, New Hampshire, Massachusetts, New Jersey, North Carolina, South Carolina, Florida, Texas, California, and Ohio. These agencies are engaged in securing data which will be, or have been, supplied to the Federal Board above referred to and which will swell the information in the hands of that Board. Several of these agencies have cooperated with the Beach Erosion Board in conducting important studies and formulating reports dealing with more pressing aspects of coastal erosion. The Board has itself made a recent notable contribution to coast protection knowledge in its first interim report published in 1933. These studies should be continued as indicated hereafter.

Problem

The problem to be solved in the protection of ocean shores is the provision of a number of safe bathing beaches for the health and recreational activities of the public, adequate for the present and future population, and the protection of the structures which are at present situated along the ocean front and which represent investments amounting to hundreds of millions of dollars. The destruction of this property not only means loss to the individual owners thereof, but also to the States and the United States, inasmuch as the tax ratables are reduced when catastrophe occurs. Consideration is also necessary of the effect of certain classes of work for improvement of navigation which may have a decided effect on the adjoining beaches. Instances are known where the construction of jetties at the entrance to harbors has caused considerable damage to adjoining property. Other instances can be cited where a considerable amount of money has been spent for beach protection works which have caused great damage to adjoining property; also protection works have been built at a cost far in excess of the amount necessary to have constructed efficient shore protection works. It therefore appears that the Federal Government might properly concern itself with formulating broad general policies relating to coastal protection and advise State and local agencies as to appropriate methods and procedures.

For this purpose scientific studies relating to the complex elements of waves, tides, currents, etc., as affecting the beaches and shores of the United States should be continued under the auspices of the Beach Erosion Board, and cooperative investigations with State and local agencies, should be expanded. The Federal Government should also assist in the construction of work for the protection and improvement of the beaches and shores of the United States.

Under the above program the words "beaches" and "shores" obviously cannot refer to all shorelines of the United States, since a great deal of that shoreline is held in private ownership, and as such, cannot be used by the general public for health and recreational purposes. It is also obvious that two similar beaches, each subject to erosion, each of the same length, but one serving 100,000 people and the other serving 100 people, do not deserve the same consideration; as the former is much more of a national problem than the latter. The extent of Federal participation cannot be determined by the value of the property, the number of people using the beach, the proximity of the locality to centers of dense population, or the probable condition of the beach when improved, considering any one single factor, but by a general summary of the benefits to be derived in comparison to the cost thereof, for each location.

A reasonable program of research and investigation has been prepared which will supply the requisite basic design data, and which may be carried on at one or more locations, depending upon the desire of the administration, and which will supply employment for many of the present unemployed.

The cost of these studies in six different localities is approximately $250,000. Investigations at a greater or lesser number of localities could be made at a proportionate figure. The research and investigatory pro-

NATIONAL RESOURCES BOARD
WATER RESOURCES SECTION
AREAS OF
COASTAL EROSION
IN THE
UNITED STATES
LEGEND
Indicates location of Coastal Erosion where detailed investigations have been made, usually in cooperation with U. S. Beach Erosion Board
Indicates location of Coastal Erosion where report of investigations made in cooperation with U. S. Beach Erosion Board have been published
Indicates location of known consequential Coastal Erosion where detailed investigations have not been made
Scale 1:8,000,000
100 0 100 200 300 400 500 600 Miles

gram recommended to be carried on under the auspices of the Federal Beach Erosion Board is as follows:

a. Secure the relationship of beach profiles to various weather conditions.

b. Investigate offshore bars, their origin and changes, and their effect upon the adjacent foreshore.

c. Investigate the cause of erosion and fill on the ocean bottom offshore.

d. Investigate longshore sand movements.

e. All of the above (*a* to *d*) to be correlated if possible with the conditions of wind, waves, and weather.

f. Investigate the relation between the size of beach material and the slope of the foreshore at various locations and in particular with large sized beach material.

g. Determine the maximum forces of wave attack on existing structures by means of reliable wave dynamometers.

h. Make investigation of the effects of protective works.

i. Compile photographs and descriptive records of the present conditions along beaches that are liable to require study or investigation in the future.

j. Investigate the currents due to tide, winds, waves, and litteral drift.

k. Make a further determination of the effect of waves of different sizes on the amount of material held in suspension at various distances from the bottom and from the shore.

l. Continue the wave tank experiments, which have already been productive of many valuable practical results.

m. Make a search of existing literature and records for factual data, summarizing data believed to be particularly valuable and indexing data to be of possible but not probable value.

n. Investigate the effect of jetties at the mouths of inlets and compile such data as are available pertaining to them. Make model experiments to determine the similitude between nature and the model tests.

Well-designed groins properly tied into bulkhead have produced wide and stable beach, near Cape May, N. J., where previously existing beach had been seriously eroded

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PART II

VI. THE GREAT DROUGHT OF 1934

The unprecedented droughts which occurred in most parts of the United States during the period 1930–34 caused damages amounting to billions of dollars, required large-scale relief measures, and served to emphasize the need for a coordinated attack on the problems of water use.

Droughts are caused by prolonged deficiencies in normal rainfall, often extending over several years, so that the cumulative effect of lowered ground water levels is superimposed upon seasonal rainfall inadequacy. The long period rainfall records at St. Paul, Minn., and Marietta, Ohio, shown on page 299 clearly indicate severe drought conditions recurring at intervals of from 30 to 40 years, and also that generally droughts in one part of the country are not always synchronized with droughts in other parts.

Great floods are often, perhaps usually, relatively local phenomena. Great droughts always have a large regional aspect, being affected by major (though temporary) changes in the atmospheric circulation over wide areas of land and sea. Floods occur, produce damage, and are quickly gone. They may always be controlled by man if there is sufficient justification for the expenditure involved. Droughts come on insidiously, last a long time, and may affect agriculture and other human activities for years after normal rainfall returns. Man has thus far been unable to control climate over a sufficiently large area adequately to mitigate the causes of severe droughts. While the causes are not preventable, the resulting distress may be ameliorated in large measure by adequate programs of water conservation and land use.

I. Physical Conditions of Drought

The most widespread environmental result of drought is shortage of soil moisture, but corollary recessions in the ground water table, and concomitant reductions in stream flow are of great social and economic significance.

Precipitation Deficiency: During the spring of 1934 precipitation in areas west of the Mississippi River fell far below normal in consequence of the stagnation of a relatively hot air mass over the interior. Figure 1 (b) shows that by August the percentage of normal accumulated precipitation was as little as 50 percent and even 40 percent over large portions of the Midwestern and Western States. This deficiency, in combination with excessively high temperatures, caused the drying up of grasslands and crops, the lowering of shallow ground water levels, and the reduction of stream flows. The shortage of soil moisture and the diminution of stream flow was especially serious because the snowfall of the previous winter had been meager, and because in some areas, such as the eastern Dakotas, precipitation had been deficient during the 4 preceding years. Drought so severe that some scientists had thought it would not be duplicated for scores of years had occurred in most of the East-Central States during 1930–31, and, as shown by figure 1a, full recovery had not taken place in every area when the 1934 drought set in. The

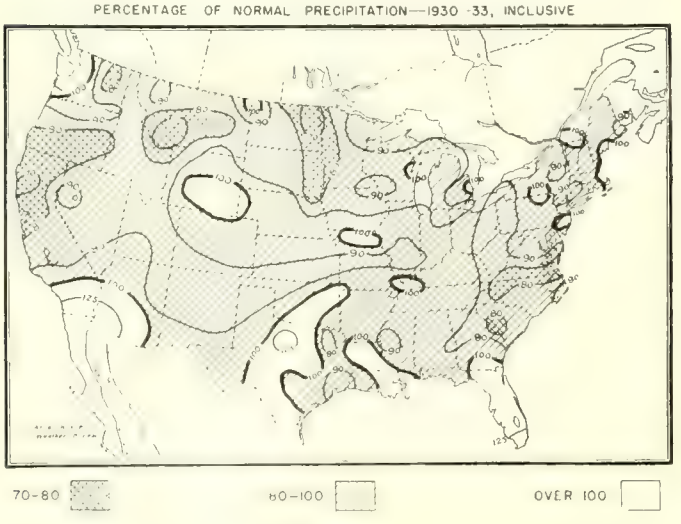


Figure 1a.

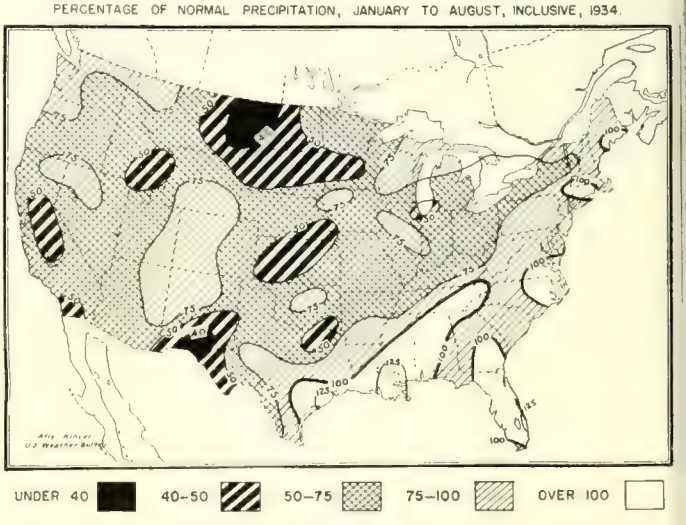


Figure 1b.

deficiencies in ground water particularly had in many areas not been replenished since 1930, and, rainfall deficiencies continuing, the recent drought was the result of cumulative conditions which had been in progress for several years. In semiarid and subhumid regions the continued negative departures from a normally meager precipitation meant that there was not sufficient rainfall even to supply moisture to the topsoil, let alone enough to replenish the ground water supplies, and this accounted in part for the widespread dust storms which in May dramatically carried the story of the great drought to eastern cities.

Ground Water Supplies: The lowering of the ground water table which was caused in part by a cumulative deficiency in precipitation over much of the Great Plains and the central lowlands is mentioned in the preceding section on ground water. Depletion of from 10 to 30 feet was not uncommon over large areas, as indicated on page 309. A rainfall shortage may cause large, moderate, or little depletion of ground water supplies, depending upon the character and structure of the geological formations in the area affected.

Surface Water Supplies: The effect of the drought on stream flow was pronounced and widespread. New minimum flows of record were experienced during 1934 on the main stems of the Kansas, Platte, Mississippi, Arkansas, and Gasconade Rivers, and on the Red River of the North. Throughout the drought areas the discharges of the main streams not only reached very low flows at an early date, but continued in meager quantities during the late spring and summer. On these western rivers in 1934, as on those of the Central and Eastern States during 1930, many previous estimates of minimum flow were broken. Since low water flow is derived chiefly from ground water supplies, marked rainfall deficiency is not necessarily accompanied by surface water shortage. Conversely, very low flows may occur during periods when rainfall, although sparse, is so distributed in time that while soil moisture is not reduced notably, very little precipitation reaches the ground water table. During the recent drought all factors combined to produce both deficient stream flow and soil moisture.

Will the Drought Recur?: Severe deficiency in precipitation is not a new aspect of the American environment. Droughts of equal or nearly equal magnitude have occurred before, as in 1894–95, in 1910 and in 1930–31. There is every reason to believe that they will occur again. The mean precipitation for a locality is rarely experienced in any 1 year; departures from the mean of greater or less magnitude are the rule. Maps showing those areas in which large deficiencies are particularly frequent are shown facing page 294 and also in the report on land use.

Can Droughts be Predicted?: Since droughts are a normal phenomenon, it may be asked whether they occur with such regularity that they may be predicted. Unfortunately it is impossible as yet to distinguish any pronounced rhythm of weather conditions from year to year. Various investigators have attempted without conspicuous success to segregate 11-year, 23-year, 50-year, and many other cycles. Those long-time cycles which have been recognized are either so vague as to be useless for forecasting purposes, or, if delimited in a precise manner for the period studied, are not applicable to subsequent years. The records for Marietta and St. Paul (see page 299), illustrate some of the difficulties of determining periodicity. They reveal striking dissimilarity between the two stations in periodicity, and between one part of the record and another part for the same station. Longer records and new methods of analysis may ultimately provide methods of forecasting droughts. For the present, all that may be asserted with confidence is that dry periods are certain to recur. The year 1935 may bring abundant rainfall and a definite "breaking of the drought" in stricken areas. On the other hand, it may bring as little rainfall as did 1934. Once the drought is definitely broken, no one can determine when another will occur. This raises a third question.

Is Our Climate Growing More Dry? The alternation of wet and dry periods in many areas cannot be denied. There is likewise no doubt of the occurrence of great variations of climate in geological times, as measured in tens of thousands of years and as exemplified in the glacial periods. Strong evidence has been advanced to show that major climatic fluctuations have taken place since the last glaciation, but the present importance of these secular trends in climate is open to question. It is not possible to assert that the climate of any area is getting drier in the sense that each successive peak of high precipitation and each successive trough of low precipitation is lower than the preceding one. If such trends are operative they probably will become perceptible only over a period of several hundred years, and they are therefore of slight immediate significance.

The moving averages of annual precipitation shown facing page 296, indicate rather pronounced trends over 2 or 3 decades, but these trends cannot be taken as indicative of continuing changes of similar magnitude. Rather, the prospects are for a recurrence of both wet and dry periods, and of droughts no less serious than the most recent one.

II. Economic Consequences of the 1934 Drought

The direct damage inflicted by the 1934 drought because of shortages in soil moisture and in ground and surface supplies was greatest in agriculture, although other human activities also suffered severely.

Deficiency in soil moisture caused reductions from the averages of 10 percent in both the corn and wheat

crops as estimated by the Department of Agriculture, these reductions being experienced for the most part in the Dakotas, Nebraska, Kansas, Missouri, southwestern Iowa, western Illinois, Oklahoma, and Texas. Pasture and feed conditions were extremely bad throughout the greater part of the Mississippi Basin, the Lake States, and southern California, and were poor in the southwest basins and in the Great Basin. Most of the trouble was due to lack of soil moisture, but large areas with some forage were useless for grazing purposes because of lack of drinking water for stock resulting from low stream flows, the exhaustion of reservoirs, and the failure of springs and wells. On account of the inadequacy of impounded supplies, many irrigation projects were forced to limit crop production; some were obliged to use all available water for livestock, as at Newlands. By August all storage reservoirs in Utah, with a single exception, were exhausted.

In many parts of the Great Plains and the Great Basin, and expecially in the Imperial Valley, not only were crops and pastures damaged, or completely destroyed, but farmers were hard pressed to find water for domestic purposes. Supplies over large areas having restricted ground water resources were greatly reduced, in some localities they gave out completely, and even in many areas of abundant ground water the wells proved to be of inadequate depth. The direct damages suffered by agriculture have been estimated by unofficial agencies to be in the neighborhood of 5 billion dollars. At the same time it is estimated that the gross cash income of farmers will show a substantial increase over 1933, but such gains made at the cost of disruption of business activity, of acute personal hardships, and of tremendous wastes of human energy cannot be regarded as desirable from a broad social viewpoint.

Some irrigation projects, such as Carlsbad and Newlands, proved quite inadequate to supply sufficient water for agriculture, others such as the North Platte were forced to curtail delivery of water to the extent of affecting agriculture adversely; and still others such as the Rio Grande and Boise, while curtailing water use to some extent, were successful in preventing the serious crop damages which were experienced in adjacent areas. Had the Boulder Dam been in operation the terrific damages in the Imperial Valley would have been greatly alleviated. All of this leads to the conclusion that water conservation for drought insurance is feasible for much of the arid and semiarid regions, but that to be effective it must be predicated upon basic hydrological facts and carried out according to a planned program of water and land use.

In general, there were few instances of serious shortage in urban water supply. In a few towns, however, notably in southern Iowa, northern Missouri, and Utah, serious deficiencies were experienced, and, as in the case of the drought of 1930 in the eastern United States, in many towns water users were placed on short allowances for a time. Public health does not appear to have been affected to an appreciable degree except in Missouri and Minnesota, where slight increases in the typhoid rate seem to have been due to the development of new or infrequently used water supplies which were subject to pollution.

Navigation on the Missouri, Arkansas, and Red Rivers was impossible because of low water, while on the Upper Mississippi the existing regulatory works proved inadequate to maintain the minimum project depth.

The effect of the low stream flows on power is indicated in a rough way by the fact that during the early summer of 1934, when the total power production in the United States increased by 4 percent over that of the corresponding period in 1933, the amount of water power produced in Wisconsin, Minnesota, Iowa, Missouri, and Arkansas declined sharply. In some States this decline involved a decrease in total power production, while in others it was accompanied by an increase in fuel-power production.

III. Remedies for Losses From Drought

Measures calculated to relieve or prevent drought damage may or may not be economically feasible. It has long been common practice to design water-supply systems to yield the desired amounts of water in about 95 out of 100 years, with the expectation of having to curtail domestic consumption about once in 20 years on the average. So, too, it may be more economical to limit crop production on an irrigation project in years of drought than to build the additional works to insure abundant supplies every year. In some cases, infrequent relief may be less expensive than permanent prevention.

Direct relief in 1934 as administrated by the F. E. R. A., the A. A. A., and the F. C. A. took the form of grants of food and clothing, provision of work for those unemployed as a consequence of the drought, purchase of about 7,000,000 cattle and 5,000,000 sheep for processing or shipment to areas having pasture, purchase of feed, purchase of land, and special seed and crop loans. Most of these activities were carried on in emergency drought counties and part of them in secondary drought counties, and they had cost the Federal Government about $300,000,000 to October 15. Of the 43 States which received a total F. E. R. A. relief grant of about $78,000,000, the Great Plains States (except Wyoming) and California, Illinois, Iowa, Minnesota, Missouri, Utah, and Wisconsin each received more than $2,000,000. The expenditures for livestock were distributed for the most part over the same areas. As a further means of drought relief, the number of

men in Emergency Conservation Work camps was increased by 50,000 at a cost of $48,000,000. With the exception of certain phases of the conservation camp and emergency work projects, the expenditures served to repair damage already done, or to tide sufferers over for another year. It was alleviation of distress, not prevention of it, and represented a cost that should be charged to the account of drought damage.

Preventive measures, in contrast with relief activities all involve a change of existing conditions, whether of environment, land use, or water use.

Change in land use constitutes an important type of preventive work. The desirability of readjustments in the systems of farm management and of farm practice in several areas of notable distress is discussed in the report of the land use section. Such changes are, however, closely related to changes in water use because in some areas the prosperity of agriculture depends upon the effective use of water for irrigation and drinking purposes, and in other areas the most desirable program for water use varies in accordance with the most profitable land use as determined by conditions of soil, topography, and marketing. The recent drought has already caused marked changes in the type of farming in some areas and has even caused the evacuation of certain small districts.

The chief measures of water conservation revolve about the development of new sources of ground water and the more effective regulation of surface water. The activities of the F. E. R. A. and the E. C. W. have embraced such measures as the cleaning of springs, the drilling and digging of shallow wells, the deepening of old shallow wells, the drilling of deep wells to horizons not used previously, the construction of small farm reservoirs and of large reservoirs on streams, the pumping of water from streams, and the launching of water-spreading and field-terracing projects. Some sort of aid was imperative. In places the private and F. E. R. A. well-digging and pumping operations assumed the feverish aspects of an oil boom. Considering the lack of preparedness, emergency water-conservation measures were well executed. One important outgrowth of drought conditions has been the extensive development of porous hose irrigation in certain areas. This is described in the paper on Conservation and Use of Water on Farms in Humid Areas.

Too often, however, the emergency work of 1934 displayed acute deficiencies which may be attributed to three factors. First, much basic information was lacking on the quantity and quality of ground water, on stream flow, on run-off, and on evaporation, to name only a few items. In parts of Nebraska wells were drilled in strata bearing only slight amounts of water, while in Kansas shallow ground water shortages were serious in areas where the availability of artesian supplies is as yet undetermined. Of some 350 small dams built in South Dakota, probably one-third will not last out a single wet season because the spillways are not adequate to care for flood run-off. Some larger dams were built on sites which had received only a hasty geological examination.

Second, numerous techniques of water conservation require further study. The effect of terracing on soil moisture, the practice of water spreading, the relation of small reservoirs to the water table, the forecasting of run-off from snowfall, and other relations and practices described in the paper on Conservation of Ground and Surface Waters are not thoroughly understood. These must receive attention by skilled investigators before they can be recommended for widespread application by farmers, towns, and relief agencies.

Third, programs are lacking for the execution of those measures deemed feasible. Determination of the best adjustments of land and water practices in a given area has been left too often to opinion unsupported by investigation, and the location and design of specific works has been of necessity hurried. Most of the E. C. W. camp work, induced by the drought, excepting that on Indian reservations and a few Forest Service projects, had no direct relation to drought, and energy which might have been turned toward some permanent improvement of conditions in the semiarid plains and basins was directed along other lines. The planning work now under way in such States as Montana, Utah, and Kansas holds promise, but it is handicapped by lack of certain technical advice. The present organization of Government fact-finding bureaus is not adapted to program-making. A case in point is the congressional precedent which prevents Geological Survey experts from cooperating in the expenditure of Federal Emergency Relief funds.

IV. Conclusions

Droughts are recurrent, but not predictable. Shortages in water supply have caused severe damages, but the latter are in most cases technically avoidable. Shortages in soil moisture may be remedied in part by water conservation measures, and in part by changes in land use. Insofar as water use is concerned, the benefits of preventive measures should be balanced against their cost, and against the cost of direct relief, before permanent drought remedies are undertaken. The greater share of the work should continue to be done by landowners and municipalities, but if the errors of the past are to be avoided sound, and coordinated guidance must be available. This requires a clearing house of existing information, the initiation of a unified

plan of further surveys and research, and the application of accumulating knowledge to the framing of broad conservation programs for the various areas having common land and water problems.

The prevention of drought damages should claim the immediate attention of an appropriate continuing agency, and work should be begun before memory of the recent distress grows dim. Otherwise, the next severe drought will find many areas as unprepared as they were during the last one, once again direct relief on a large scale will be necessary, and again water conservation measures will be hurried and faulty.

SECTION II
VII. FLOOD CONTROL

No year passes without the occurrence of more or less serious floods somewhere in the United States, and destructive inundations may occur at any time in any section of the country. The aggregate direct damages caused by them has been estimated roughly to average $35,000,000 annually. In addition, there are indirect and intangible losses for which no allowance commonly is made. These are more widespread by far than the direct and tangible losses, and may, indeed, affect the entire country. Flood losses, both direct and indirect, have been increased greatly by the unwise encroachment of settlement and industry upon many lowlands subject to inundation.

The benefits of flood control, no less than the damages caused by floods, extend far beyond the limits of the communities primarily affected. In many cases, there is not only a local interest in control, but also a State interest and a Federal interest. For this reason, and others, it always is exceedingly difficult to make an accurate estimate of the value of flood protection. Broadly speaking, complete control of the floods of almost any river is possible by one means or another, though it may be far from justifiable. Thus it may be economically feasible to provide protection against the highest flood that may occur on an average of once in 50 years, but not for the highest one that may occur once in a century. In many cases, fortunately, certain works designed to regulate or control the flow of a river may not only reduce or eliminate the flood hazard along its banks, but may also increase its navigability, provide water for irrigation, make possible the development of power, or otherwise serve human interests. Thus a multiple-purpose project may be practicable where a single-purpose project would be utterly impracticable.

Flood-control works are of four general types:

(*a*) Storage reservoirs, to impound flood waters for later release.

(*b*) Retarding basins, automatically to retard and smooth out flood peaks.

(*c*) Channel improvements, to increase capacity or facilitate flow.

(*d*) Levees, to protect from overflow the bottomlands behind them.

In general, storage reservoirs are most satisfactory, especially if the impounded waters can be put to multiple uses, but in many cases flood control by storage is impossible and in many others it is impracticable. The greatest example of control through multiple-purpose storage is afforded by the project under construction in Boulder Canyon on the Colorado River. The best example of complete protection involving the use of retarding basins is found in the Miami Conservancy District of Ohio. Channel improvements rarely, if ever, afford adequate protection by themselves, but they have had a place in many large projects. The traditional method of controlling floods, exemplified best along the lower Mississippi, is by means of levees. This form of protection has the advantage of being direct and visible, and the levees serve as a standing warning against the occupation and use of the part of the flood channel that remains exposed.

The interrelation of floods, silting, and erosion control is noteworthy. In those areas where soil erosion is acute, notably in the southern part of the country, a large proportion of the total annual flow may come down in a few floods. These carry heavy burdens of eroded soil, depositing it in river beds and reservoirs, causing serious injury to channel capacities and storage volume. The economic loss from this aspect of flood flows is of large proportions and is to some extent preventable by erosion-control measures.

North Pacific Drainage

Flood damages in the North Pacific drainage are confined largely to the region west of the Cascade Mountains. Here 36 streams, including the lower Columbia River, are recorded as subject to destructive floods. Complete figures on average annual damages are not available, but the total property damage caused by the last flood on 24 streams is calculated at about $11,424,000. Frequencies of destructive floods range up to 12 years.

Relatively little has been done in the district to effect control of larger floods. There has been some scattered diking, channel rectification, and bank revetment. The total flood-control expenditures to date are estimated at $8,834,000 for the six streams for which such data are available. It is doubtful whether reservoir control is economically feasible, except in a few areas, and then only when flood protection is combined with other benefits.

South Pacific Drainage

The major existing flood problems in this area are found in the San Joaquin-Sacramento Basins, where

the floods of 1907, 1909, and 1911 inflicted a total damage of some $10,000,000, and in Los Angeles County, where flood damage has been serious. No figures are available on average annual losses.

In the San Joaquin Basin, about 800,000 acres of land have been inadequately protected by levees. Along the Sacramento River, a well-developed protection plan has by now been about 85 percent completed and will afford adequate protection when it is finished.

The Sacramento project, consisting of levees and bypass floodways, is one of two major flood-control projects in the region. The other is found in the Los Angeles County flood-control district, where the solution has been sought by providing detention storage to decrease volume of peak flow—the surplus run-off being partially conserved through direction to underground storage by means of spreading works.

On the American River a levee and bypass project is now 95 percent completed, while on the Santa Ana, some work has been done on debris dams, levees, and spreading works.

Colorado River Drainage

Although floods were once a menace on the lower Colorado River, the construction for this and other purposes of Boulder Reservoir on the main stem, of Roosevelt Reservoir on the Salt River, and of Coolidge Reservoir on the Gila River has completely eliminated the danger of flood flows downstream from these points. A few small areas strung along the channels above these reservoirs remain subject to flooding.

Southwest Mississippi Drainage

Approximately 7 million acres of land east of the 99th meridian are subject to destructive floods in this district, caused by heavy spring rains.

More than 2,000,000 acres of land have levee protection at present, but the levees, constructed in an unplanned manner, are inadequate in nearly all cases.

Projects are now under consideration to provide further levee protection for some 700,000 acres of land and a number of communities, and to give complete or partial protection to land along a number of rivers by means of multiple-purpose reservoirs.

Missouri River Drainage

About 2,275,000 acres of farm land and some 26 municipalities in the Missouri Basin are subject to destructive floods causing an average annual direct loss of about $2,800,000. The flood hazard is localized in the headwater areas where ice jams are largely responsible, and in the Kansas River-lower Missouri area, where spring rains cause heavy flood damages.

Approximately 1,200,000 acres of land and a number of communities now have levee protection that is largely inadequate. Further protection of rural land is not deemed economically feasible, but the protection generally by means of levees, of some 13 communities of various sizes is considered feasible.

Protection by means of reservoirs seems at present possibly feasible only in the case of Kaw River lands.

Upper Mississippi Drainage

The most damaging floods in this drainage area are those which occur during the late spring and early summer in the southern half of the area. The flood hazard on the Wisconsin and upper Mississippi Rivers has been almost eliminated by regulatory works. On other streams, notably the Illinois River, where the average annual damages exceed $2,000,000, the levees of agricultural drainage enterprises have so constricted the channel that the height of flood flows has been increased greatly and the levee system has proven entirely inadequate.

Lower Mississippi Drainage

Most of the 40,000 square miles or more of alluvial land of the lower Mississippi River was subject to occasional flooding from the main stream or its tributaries when the first levees were built in 1717. A $300,000,000 levee system now limits Mississippi flood waters to the main channel and about 8,000 square miles of backwater lands at the mouths of tributaries. At times of very high flow, roughly once in 13 years, an additional 4,000 square miles of floodway land will be inundated in order to prevent a repetition of the breaking of main-stem levees which caused damages in excess of $250,000,000 in 1927. Approximately 2,340 square miles in the Yazoo River Basin, 2,125 square miles in the St. Francis River Basin, and 2,000 square miles in the White River Basin are flooded on an average of once in 5 to 15 years and cause an average annual damage of at least $3,500,000. No protection is afforded to some of this land, but much of it is served by inadequate and poorly coordinated levee works, which commonly give way at times of very high water.

Western Gulf Drainage

Destructive floods occur in the coastal plain reaches of the major streams in the western Gulf drainage on an average of once in 4 or 5 years. In 1921, 172 lives and property valued at $5,500,000 were lost in the Brazos Basin. Levee districts have been formed on a number of these streams, and in a few places, notably San Antonio and Fort Worth, single- or multiple-purpose reservoirs have been constructed. Irrigation and power reservoirs on the upper reaches have acted to reduce some flood flows, but have little or no effect on run-off from many of the heavy storms which are restricted to the coastal sections.

Above.—An uncontrolled river on a rampage.—Looking upstream, the normal river channel is at the right. The flooded area extends all the way back to the left; wreckage in foreground; flooded homes and bridge in middle distance; at the right is a main business section of the city flooded 12 feet deep.

Below.—The same river (in flood) under control.—The stucco apartment house in foreground at left is new but the house at its right is the same one shown in the upper picture. The buildings at the right may be identified in both pictures. Flood control reservoirs above the city provide this control.

Ohio River Drainage

Floods of average intensity do relatively little damage in the Ohio Basin. At intervals of from 25 to 100 years, however, this basin experiences terrific floods which cause serious property damage, and, in some cases, loss of human life. In addition to its local effect, the Ohio ranks as the major flood producing tributary of the Mississippi.

Control of these great floods is made difficult because of their magnitude (1,000,000–1,500,000 c. f. s.) and because the land adjacent to the main stem is occupied by cities, factories, and farms. Vast retarding basins, therefore, probably are not practicable on the Ohio River proper, and flood-control works may have to be restricted to dams on the tributaries and levees along the major streams. More than $40,000,000 have been spent by local interests to construct partial or complete flood-control works in widely distributed parts of the Ohio Basin. Fifteen reservoirs recently authorized, and 13 others that appear to be feasible, would have a considerable effect on Ohio River floods, and would also result in a large measure of local protection.

Red River, Great Lakes, and St. Lawrence Region

Much agricultural land and a few towns in the nearly flat, lacustrine plain of the Red River Basin are subject to flooding from the main stem and tributaries during the spring, and particularly at times when discharge is retarded by ice in the channels to the north. Although no truly severe floods have occurred since 1882 and 1897, a flood of moderate height occurred in 1916, and more severe ones may be expected. Proposals for flood control work have received little study during the recent period of dry years.

Floods cause occasional damage on a few reaches of the Great Lakes tributaries in the glaciated lowlands of Wisconsin, Indiana, Michigan, and Ohio. Most of the affected towns and cities have met the problem by constructing local channel improvement works, as at Milwaukee and Grand Rapids, but a few urban areas and many agricultural areas remain unprotected.

In the minor Great Lakes-St. Lawrence drainages of Vermont and New York severe fall floods are a menace to bridges and buildings which restrict unduly the channels in the valley bottoms. Some of the valleys are now protected in part by power reservoirs. The area of most serious flood damage, the Winooski Valley, has recently been given protection through the construction of two detention reservoirs by C. C. C. labor.

The St. Lawrence River has a remarkably uniform discharge, but during the winter months severe ice jams sometimes cause increases in flow line of as much as 25 feet above the summer level in certain reaches, notably in the vicinity of Barnhart Island.

North Atlantic Drainage

Storms of the intensity of that which caused the great New England flood of 1927, and with an average frequency of about 100 years, are possible throughout almost all of this area. Physiographic conditions are conducive to the development of strong flood flows in most New England and New Jersey drainages, and on the Hudson River above Albany. On the Susquehanna River ice jams have caused very high waters. Damages experienced in the relatively narrow valleys have amounted to as much as $10,000 per square mile of the drainage area of the river. On some New England streams, such as the Deerfield River, flood flows are absorbed in large measure by storage reservoirs for power or water supply. On other streams, such as the Connecticut River, municipalities have constructed levee systems for local protection. In general, however, flood protection has received little direct attention.

Eastern Gulf and South Atlantic Drainage

Much of the land subject to flooding in this region lies on the gently sloping coastal plain, although the larger floods cause material damage in the Piedmont areas, and sometimes in the mountain regions. A good deal of the land in the lower reaches of the major streams is swampy, and a considerable portion of the valley bottoms upstream is subject to flooding which commonly occurs in the South Atlantic drainages in the fall, and in the eastern Gulf drainages in the spring. Only a few urban areas are menaced by high water, and most of these are adequately protected by channel improvement and levee works. A major exception is Augusta, Ga., which is in danger of flooding from the Savannah River. The expense of protecting the cultivated or tillable lands is so great that it is justified in only a few places. Hurricane tidal waves on Lake Okeechobee, Fla., constitute an outstanding flood hazard and their damaging effect is now being reduced by levee construction at a cost of $17,000,000.

Rainfall, Run-off, and Flood Frequency Studies

In order to plan intelligently for flood control and flood protection works for any locality, it is necessary to secure and study all of the facts which can be found relating to the frequency and magnitude of past floods in the region concerned. Although many scattered and fragmentary records have been preserved of floods which have occurred in the past great enough to cause serious damage, no complete compilation exists anywhere of all such data in such form as to be available for general consultation and use. In many regions such records as do exist cover too short a period of time, and are too

scanty, to afford a reliable estimate of the frequency of occurrence of floods of different sizes, and to reveal the size of the greatest flood that may occur sometime n the future and against which protection should be provided. In such cases it is necessary to consider the flood history of neighboring and similar areas and apply to the region under consideration conclusions drawn from such histories.

Since in many cases rainfall records are much more complete than data concerning past floods, it is customary also to study rainfall data in the endeavor to learn from them something regarding the size and frequency of floods that may be reasonably expected to occur in the future. Numerous attempts have been made in the past to deduce a definite numerical relation between the occurrence of heavy precipitation and the floods resulting therefrom, but hitherto the time and means needed to unravel all the effects of the numerous factors that affect this relationship has not been available to any one person or agency.

It seemed opportune, therefore, to the Mississippi Valley Committee in the early stages of its work to attempt to further the use and control of the water resources of the country by initiating a comprehensive compilation and study of existing flood records, and a new attack on the problem of discovering a workable procedure for deducing run-off characteristics from rainfall records. An allotment of $45,000 was secured from the Public Works Administration, and the work was entrusted to the staff of the United States Geological Survey. Advice as to methods of procedure has been obtained from committees of the American Society of Civil Engineers and the American Geophysical Union. The work has been organized and encouraging progress has been made to date. Long-term records of floods have been analyzed and tabulated, numerous applications of various statistical procedures for estimating flood frequency have been made, an extensive bibliography has been prepared, and a paper containing certain new methods of approach to the subject of flood frequencies has been written by a member of the staff and published by the American Society of Civil Engineers.

By the end of the fiscal year these initial studies will have been completed. It is planned to have the results published promptly. The work will illustrate the results that can be obtained from a wide-spread cooperative effort to extend the limits of our scientific and technical knowledge in a field much needed for the more efficient control and use of water. The need for the continuing compilation of records and further technical researches and investigations will doubtless become apparent for the successful solution of the almost innumerable problems that may be expected to arise in the further utilization of our water resources.

SECTION II
VIII. PUBLIC WATER SUPPLIES

In the development of any community it is imperative that a water supply be available which is satisfactory as to both quality and quantity. The problems involved in securing a public water supply for a small isolated area are of local interest, but the same problems may assume regional, national, or even international importance in densely populated sections. Cities requiring large volumes of water must depend generally upon securing their supplies from surface water frequently drawn from interstate streams, or in the case of the Great Lakes area, from international waterways. Conservation and intelligent development of such supplies is a matter requiring equitable adjustment in the allotment of these resources, which perhaps may be effected only by some measure of Federal authority. The absence of a satisfactory national policy is responsible for the recent State controversies arising in the Delaware, Colorado, and the Connecticut River cases, and the interstate and international problems which developed as a result of the diversion of the waters of Lake Michigan by the Sanitary District of Chicago.

There is much statistical information available on both the quality and quantity of the major water courses, upon which an intelligent program of conservation and development can be established. A study of these statistics, population growth, and depreciation of water quality from domestic and industrial wastes, indicates clearly the existing and predicted local and national requirements. There are three outstanding conclusions, which are:

(*a*) Existing and increasing pollution loads on surface waters cannot be continued without irreparable damage to water quality.

(*b*) The rapidly increasing consumption of water in areas of concentrated populations must be regulated by conservation, through the elimination of extravant use and other avoidable waste.

(*c*) Conservation of waters now going to waste should be more generally practised through control by reservoirs and other measures to regulate stream flow.

Sources for Public Water-Supply Systems

The sources of water for public supplies are surface waters, wells, and springs. Three-fourths of the population served by water systems use supplies obtained from surface waters, which divide themselves into two groups: (*a*) Those from large rivers and lakes, which must be pumped into the distribution system and (*b*) those from smaller upland streams, requiring storage reservoirs and pipe lines for the delivery of water to the cities, generally by gravity.

Although an ample water supply is necessary for every community, a lack of readily available sources has not been a limiting factor in the development of our cities, except in desert areas. Water of satisfactory quality can be obtained almost everywhere by proper treatment of nearby sources or by impounding the run-off of distant watersheds. The demand for an adequate supply has made it necessary for several large cities to bring water from great distances. The more notable are:

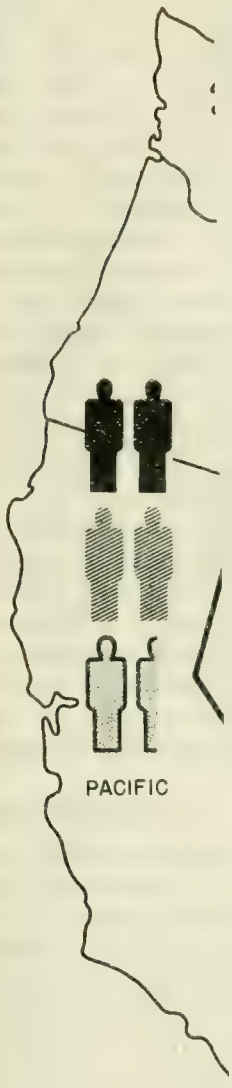
	Miles
1. Los Angeles (Colorado River) (proposed)	280
2. Los Angeles (Owens Valley)	150
3. San Francisco	170
4. New York	125
5. Boston	75
6. Tulsa, Okla	70

The proposed diversion by Los Angeles of one-tenth of the flow of the Colorado River below Boulder Dam represents an unusual case of a supply being taken from a large river and pumped many miles for use in a distant city.

There has been a distinct trend toward abandonment of the older supplies obtained from heavily polluted rivers, and the development of new supplies from less contaminated sources. This frequently involves the the expenditure of large sums of money. Albany, N. Y., formerly obtaining its supply from the Hudson has recently made this change at a cost of approximately $7,000,000. However, many large cities, such as St. Louis, and thousands of smaller communities, must resort to elaborate purification of unsatisfactory surface water as the only economically practicable source of safe water.

The large populations bordering the Great Lakes are fortunate in having an inexhaustible supply of relatively soft water, although generally it should have complete filtration to eliminate the dangers from contamination by city sewage and industrial waste.

In many parts of the United States it is possible to obtain, from underground sources, water that is clear, pure, and palatable, although often hard and highly mineralized. Accordingly, wells and springs were determining factors in the early settling of certain sections of the country, and have since been the preponderant source of water for farms and small rural communities.



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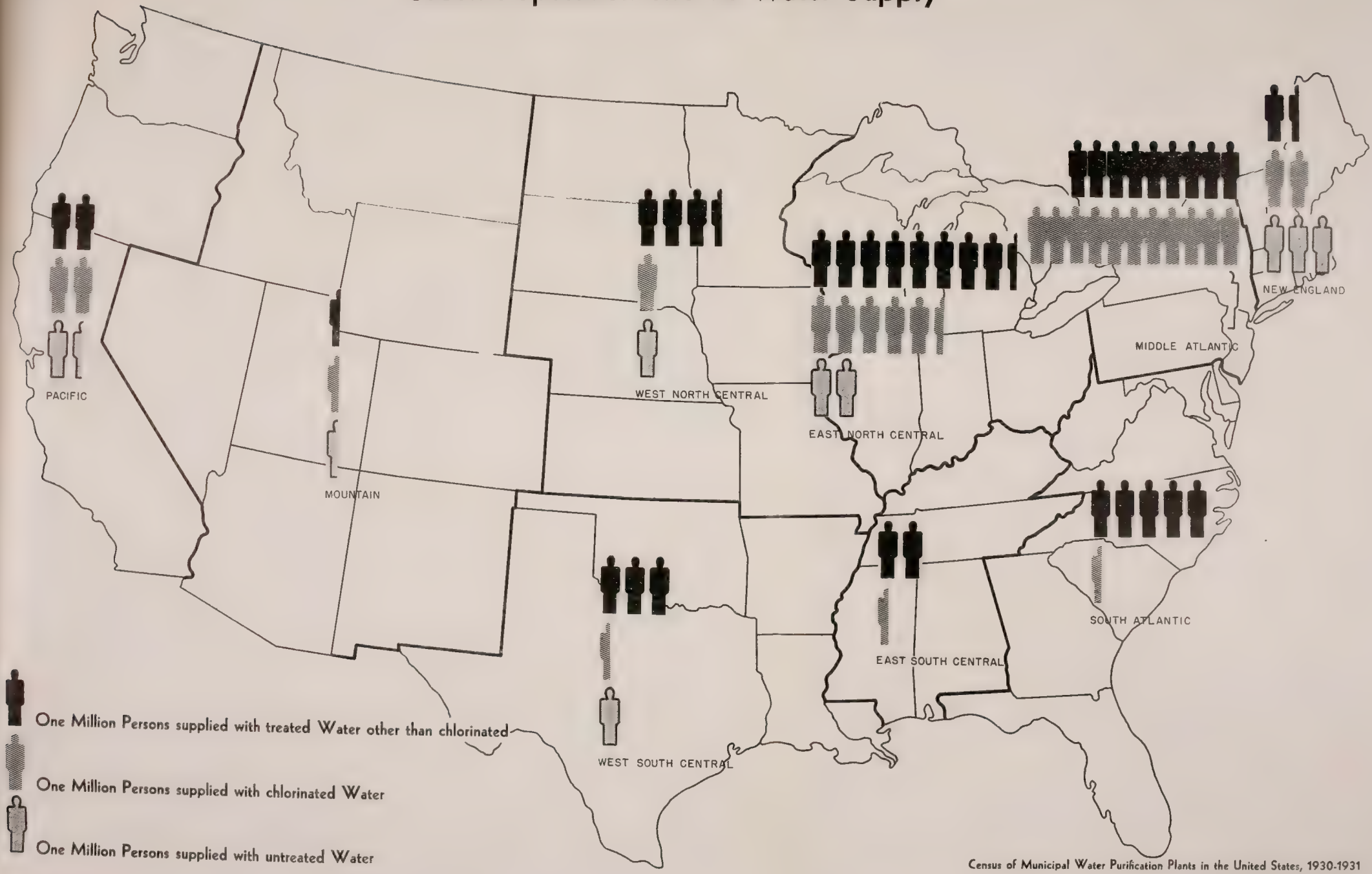
Urban Population and its Water Supply



Census of Municipal Water Purification Plants in the United States, 1930-1931

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About a third of the people of the United States live in 0 cities of more than 100,000 population, another third n smaller towns and villages, and the remainder on arms. The latter two-thirds depend extensively on round water. Waters obtained from underground ources generally do not require filtration and are uited to the public systems when available in sufficient olumes. The use of ground water is reflected in the nalysis of statistics of water systems supplying 7,000,000 persons. A fourth of this total use ground vater, but more than half of these are in the populous rea east of the Mississippi and north of the Ohio, vhere surface supplies are also abundant. Ground vater serves four-fifths of the consumers in Florida, and ne-half to two-thirds in the other States around the Gulf of Mexico. These sources are still more important n the dry Southwest.

Two and a half million consumers in 18 of the larger ities (population over 100,000) use ground water. The largest of these are Houston (285,000), San Antonio 235,000), Dayton (225,000), and Memphis (200,000). The available volume of underground supplies in cer- ain sections is limited, and excessive pumping has caused contamination by infiltration of sewage or salt vater. This has occurred in Florida, on Long Island, nd elsewhere in coastal regions.

Water Purification

Over half of the public water supply systems in the United States deliver untreated water to their consum- rs, who represent about one-fourth of the population served by public water supplies. A still larger number of persons use water that has been treated only with chlorine to eliminate the danger of contamination. The remaining 35,000,000 use water which has been subjected to some form of filtration, usually followed by chlorination. The purification of drinking water by chlorination alone is not always sufficient, because of the character and fluctuation in quality of the raw vater. Moreover, complete dependence on chlorina- ion is often a questionable procedure, because of the possible break-down of the mechanical equipment nvolved.

Some cities today are depending upon "protected vatersheds" to furnish a safe supply of water. How- ever, the increasing density of watershed populations nd the extensive development of transportation acilities (especially the automobile), are responsible or chance contamination and make it more difficult o protect such supplies.

The most practicable method of treatment now known that will provide a pure and wholesome water t all times is sand filtration and final chlorination. Because of the uncertainty of simple chlorination many cities, to assure themselves a satisfactory supply at all times, must soon install modern filtration plants. Experience has shown that these plants may be constructed at a cost of not more than $5 per capita. At this rate, the present capital investment in treatment plants, omitting distribution systems, is probably not far from 200 million dollars. It is possible that an equal amount may eventually be required to furnish safe water to the entire country.

Standards of Water Quality for Protection of Public Health

A review of the history of water-borne diseases in this country clearly indicates the national importance of this problem and the necessity for continued State and Federal control. Adequate purification, effected by properly designed filtration systems and supplementary chlorination of questionable supplies, has proven beyond question that typhoid and other intestinal diseases, contracted from the use of contaminated water supplies, can be eliminated. It should be borne in mind, however, that typhoid fever and other water-borne diseases are not vanishing calamities, but are merely controlled diseases which may recur at any time, if there is a break-down in the operation of water purification systems. This is well illustrated by Wolman and Gorman, who state, "There should be ample warning of the importance of rigid administrative control of enteric disease in the significant fact that, in spite of the rapidly declining typhoid fever death rate on this continent and Europe, three of the largest typhoid fever epidemics on record in epidemiological history have occurred in the last decade."

In the majority of States the control of the quality of the water is under the direct supervision of the State departments of health, and in the more populous States is relatively satisfactory. The control of quality of water is further extended through the administration of the use of water on public carriers engaged in interstate transportation. This supervision is adequately enforced by the United States Public Health Service, working in cooperation with the State departments of health. The standards of water quality set by the Treasury Department, administered by the United States Public Health Service, are the greatest individual control factors for assuring water of satisfactory quality, and, although only enforceable on interstate carriers, they have now been generally adopted as the basis of satisfactory water quality.

Consumption

There are about 7,100 public water-supply systems in the United States, serving 80,000,000 people. Over one billion cubic feet of water is used by this group

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Consumption

There are about 7,100 public water-supply systems in the United States, serving 80,000,000 people. Over one billion cubic feet of water is used by this group

every day. The weighted average water consumption of 37,000,000 users, living in 90 cities of more than 100,000 population, was 127 gallons per day in 1928. This average includes maximums of 270 in Chicago and 204 233 in Salt Lake City, and minimums of 53 at Oklahoma City and 50 at Lowell, Mass. It happens that Washington, D.C., and Milwaukee conformed exactly to the average. This high average per capita consumption represents, in addition to the normal domestic and industrial requirements, (*a*) leakage from faulty distribution systems and (*b*) extravagant use of water. Abnormally high consumption occurs in localities where public supplies are utilized for the irrigation of crops. Waste-control surveys have often paid for themselves many times over by disclosing causes of waste and making possible their elimination.

A noteworthy reduction in domestic consumption has been brought about by the installation of meters in many communities. Water, unlike gas and electricity, is rarely completely metered in the large cities. Under the antiquated flat-rate method of charging for water, the cost bears no relation to consumption, and there is no incentive to conserve water. The installation of residential water meters should not cost more than $7 per capita, and would be more than compensated for by savings in present operations and in new plant construction or extension to existing systems. Furthermore, the development of additional sources of water can often be postponed for many years if conservation is effected by this means.

Fire protection is an important aspect of the installation of water supplies in small communities, where, in some cases, the savings from a reduction in fire-insurance rates have more than paid for the cost of th system. However, in one large city it has been esti mated that only 6 percent of the entire water-syster costs are chargeable to this service.

Ownership

The majority of public water-supply systems in th United States are publicly owned, and during the pas 25 years there has been a marked trend toward th extension of municipal ownership.

The majority of these publicly operated utilitie have been efficiently managed, as indicated by th quality of water delivered to consumers, the servic rendered, and rates charged.

In metropolitan areas many supplies have been devel oped for the use of several contiguous communities and are controlled by special district authorities. Th first of the larger water districts was that establishe for the Boston metropolitan area. Others more re cently created are the Portland Water District, th Metropolitan District of Hartford, the North Jersey District Water Supply Commission, the Washingto Suburban Sanitary District, and the East Bay Munic ipal Utility District (California), and the Los Angele Metropolitan District.

An analysis of 67,000,000 water consumers shows that about 20 percent are served by privately owned companies. Notable examples are New Haven, Chester, Hackensack, Scranton, and Indianapolis. Private ownership is more generally limited to small cities and towns. In recent years many of these companies have been purchased and grouped under the single management of large holding and operating companies.

SECTION II

IX. WASTE DISPOSAL AND WATER POLLUTION

When domestic sewage or industrial waste is emptied into a surface stream, the resulting degradation below standards of stream cleanliness is a measure of the seriousness of pollution. There is no single index of stream pollution, and the standard for cleanliness of streams varies, depending upon the purpose for which the water is to be used. From the viewpoint of usage for public water supply, concentration of bacterial life is of major importance, and for such purposes pollution is generally measured by the numbers of sewage organisms present. It is essential, also, that the dissolved oxygen content of the water shall be in sufficient concentration to satisfy the major amount of oxidizable organic material present, to support fish life, and to prevent putrefactive action; further, that dissolved and suspended substances shall not be excessive, and high concentration of alkalis, free acids or products resulting in acidity be avoided. To meet these broad specifications gross pollution from both domestic and industrial wastes must be controlled. The limit of safe pollution loads is therefore chiefly determined by the available volume and oxygen content of the dilution water in the stream in comparison with the volume and character of the contaminating materials. These factors are measured by bacterial flora, oxygen demand, and chemical content of these miscellaneous wastes.

Domestic Sewage as a Source of Pollution

Pollution of streams by domestic sewage has become very extensive in the past few decades. Our large cities were located on the sea coast, on the Great Lakes, and along the major inland waterways. For a time the nearby volume of water was sufficient to dilute the raw sewage adequately. As population increased, and living conditions improved, consumption of water for sanitary purposes mounted, and a consequent greater amount of sewage per person resulted. Moreover, industrial development gave rise to processes requiring large quantities of water and discharging increased amounts of liquid wastes. As a result, the rate of growth of sewage discharge increased much faster than that of the population of the cities. Today many of the major cities discharge their untreated or partially treated sewage into adjacent bodies of water, which have already exceeded or are approaching their diluting capacity. In the future these conditions are likely to become still more serious. The inland cities have generally found it necessary to install waste treatment plants of some description, but many small streams are grossly polluted by untreated or partially treated sewage. Reduced stream flow during the recent dry or drought periods has emphasized the necessity for more comprehensive treatment in many localities.

The treatment of domestic sewage is an individual problem subject to widely different adjustments for each town or city. A small town with ample dilution in an adjacent stream may not require as complete treatment of sewage as a larger city where equivalent dilution areas are not available.

The seriousness of present pollution conditions in many parts of the United States, and the alarming possibilities of more intense pollution in the future are shown by the January 1932 report of the Tri-State Commission of New York, New Jersey, and Connecticut, which covers a contributing population of 10,800,000 that is expected to increase to 24,100,000 in 1970.

> The effects of pollution of the interstate tidal waters are shown most conclusively by test of dissolved oxygen in these waters. Such tests have been carried on in the waters of the New York Harbor on an extensive scale for the last 22 years. The tests show that the dissolved oxygen in all the main branches of the harbor declined rapidly between 1909 and 1916, and at a less rapid rate since that year. * * * Since 1920 the average dissolved oxygen in summer months has not gone above 50 percent. Minimum values of less than 20 percent have been noted in many parts of this harbor during the past summer (1931) with zero percent being observed in the lower East River and Harlem River.
>
> The slips between piers are collecting points for sewage sludge deposits, and must be dredged out at regular intervals at considerable expense.

The late George W. Fuller, consulting engineer for New York City, stated in 1932 that "Sewage disposal betterments are still being retarded in this region (New York City) by the requirement of the public-health laws that State authorities have to prove actual injury rather than potential menace to the public health and property. This situation spells delay either through procrastination or the formalities of litigation in courts of original jurisdiction and appeals from the decision thereof."

In general, most communities require at least partial treatment of their domestic wastes. In some cases plain subsidence for the removal of settleable solids is sufficient, while elsewhere elaborate chemical and biological processes are demanded, to insure limiting

the pollution load on the water courses into which the wastes are discharged. Comparative costs of utility services are shown in table I, and indicate that payments for waste treatment are on a far smaller scale than for other public services.

TABLE I.—*Comparative cost of various public services in moderate size communities*

	Per family per year
Gas	$40–$50
Electricity	33
Water	30
Telephone	30
Transportation	60–150
Sewers and treatment	13

In the accompanying map an attempt has been made to show the present status of sewage treatment. Data concerning 1,444 communities, having a total population over 50 million, with sewerage systems, were tabulated and classified as having:

(*a*) Complete treatment, such as activated sludge and trickling filters, or plants which would give approximately 85 percent or greater reduction in biochemical oxygen demand;

(*b*) Partial treatment, such as screens with primary sedimentation or Imhoff tanks, or plants accomplishing about 40-percent reduction in biochemical oxygen demand;

(*c*) No treatment, or only screening.

The available information about the conditions in some States has not been complete and it was necessary to make certain assumptions. However, this chart presents a relatively accurate picture of sewage disposal in the United States. From these data, a calculation has been made of the investments required to provide partial and complete treatment to the present-day population that is served by sewerage systems. The results are shown graphically on the accompanying charts.

These costs are only for plant construction and do not include the cost of land, interceptors, or out-fall lines, which may easily double the cost of a treatment works. A conservative estimate of $10 per person to provide complete treatment has been used. The cost of partial treatment may be as low as one-third the cost of complete treatment and an estimate of $4 per person has been used.

These rates were applied to the 1930 population served by sewers with no allowance for future growth or increase in percent of community sewered, which again may double these estimates in certain localities within the next 20 years.

The total investment required to give partial treatment for the 1930 population which now has sewers but no treatment is estimated to be $140,000,000, which is about equal to the amount of capital invested in existing disposal plants; and the amount conservatively calculated to give complete treatment to all communities is $380,000,000. These indicated capital requirements are in addition to P. W. A. grants of $30,000,000 for these facilities. Of the latter sum, $16,000,000 has been allotted to only two districts, viz, Washington, D. C., and Chicago.

TABLE II.—*Approximate percent of total estimated financial investment required to give partial or complete sewage treatment to the 1930 population with sewerage systems*

No.	Drainage basins—Description	Percent
I	North Atlantic	35.4
II	South Atlantic and Eastern Gulf	4.3
III	Ohio River	10.0
IV	Great Lakes and St. Lawrence River	12.3
V	Upper Mississippi River (including Chicago)	16.6
VI	Missouri River	4.4
VII	Lower Mississippi River	3.9
VIII	Southwest and Western Gulf	.9
IX	Colorado River	.1
X	Great Basin	.6
XI	South Pacific	8 4
XII	North Pacific	3 1
	Total	100.0

Industrial Waste as a Cause of Pollution

In almost every industry the processing of raw material separates part of it as waste. Frequently there are also spent processing materials—washwater, acids, ash, etc. These increase as the number of unit operations to attain the finished product increases. In some cases reclamation of wastes has effected notable savings to both industry and public; but in its preoccupation with the finished product, management has often neglected reclamation research, and has even abandoned marketable wastes, regarding them as a burden to be gotten rid of as cheaply as possible. For many liquid industrial wastes the only available disposal is a body of surface water or a public sewer. Byproducts frequently impose a heavy added burden on sewage treatment works and may seriously interfere with normal operation of such utilities. The geographical distribution of pollution by industrial waste and mine drainage is shown in an accompanying map.

It is difficult to give a general specification for the limiting permissible pollution load of surface water courses for the country as a whole, or to evaluate the magnitude and importance of specific domestic and industrial wastes, in a generalization which will be equally applicable to all of the major drainage areas. It is obvious, moreover, that sanitary regulations must be sufficiently flexible and variable to be equitable, considering the numerous factors involved in these problems. An intelligent discussion of stream-control measures must therefore deal individually with specific drainage areas and geographical districts. In view of these limiting restrictions, a brief summary of localized

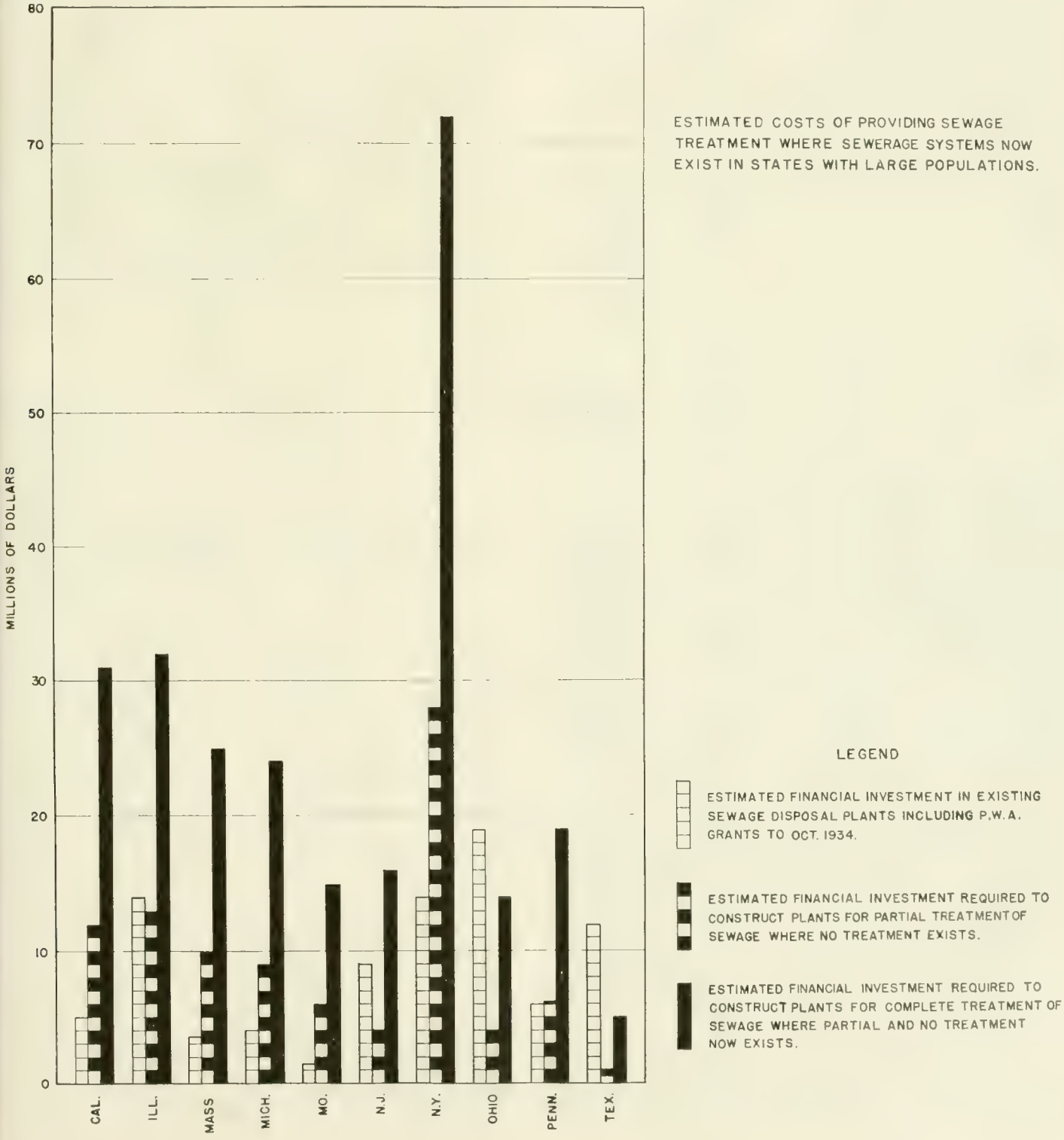
NATIONAL RESOURCES BOARD
WATER RESOURCES SECTION
DISPOSAL OF MUNICIPAL SEWAGE
SHOWING
COMPLETE, PARTIAL, OR NO SEWAGE TREATMENT
LEGEND
Complete Treatment
Partial Treatment
No Treatment
Scale
Miles

sanitary problems is presented for each major drainage region, with emphasis on the conditions existing at population centers or major foci of pollution.

North Atlantic Drainage

The pollution of surface water courses in this district is of major importance because of the intensive concentration of populations and the many widely industrialized districts within the area. Because of the diversity of industries and population densities within this area, the problems involved may be subject to different control procedures.

The disposal of wastes from inland communities adjacent to large bodies of water is almost wholly by dilution, and corrective treatment has not been considered essential up to the present time. Fortunately,



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The pollution of surface water courses in this district is of major importance because of the intensive concentration of populations and the many widely industrialized districts within the area. Because of the diversity of industries and population densities within this area, the problems involved may be subject to different control procedures.

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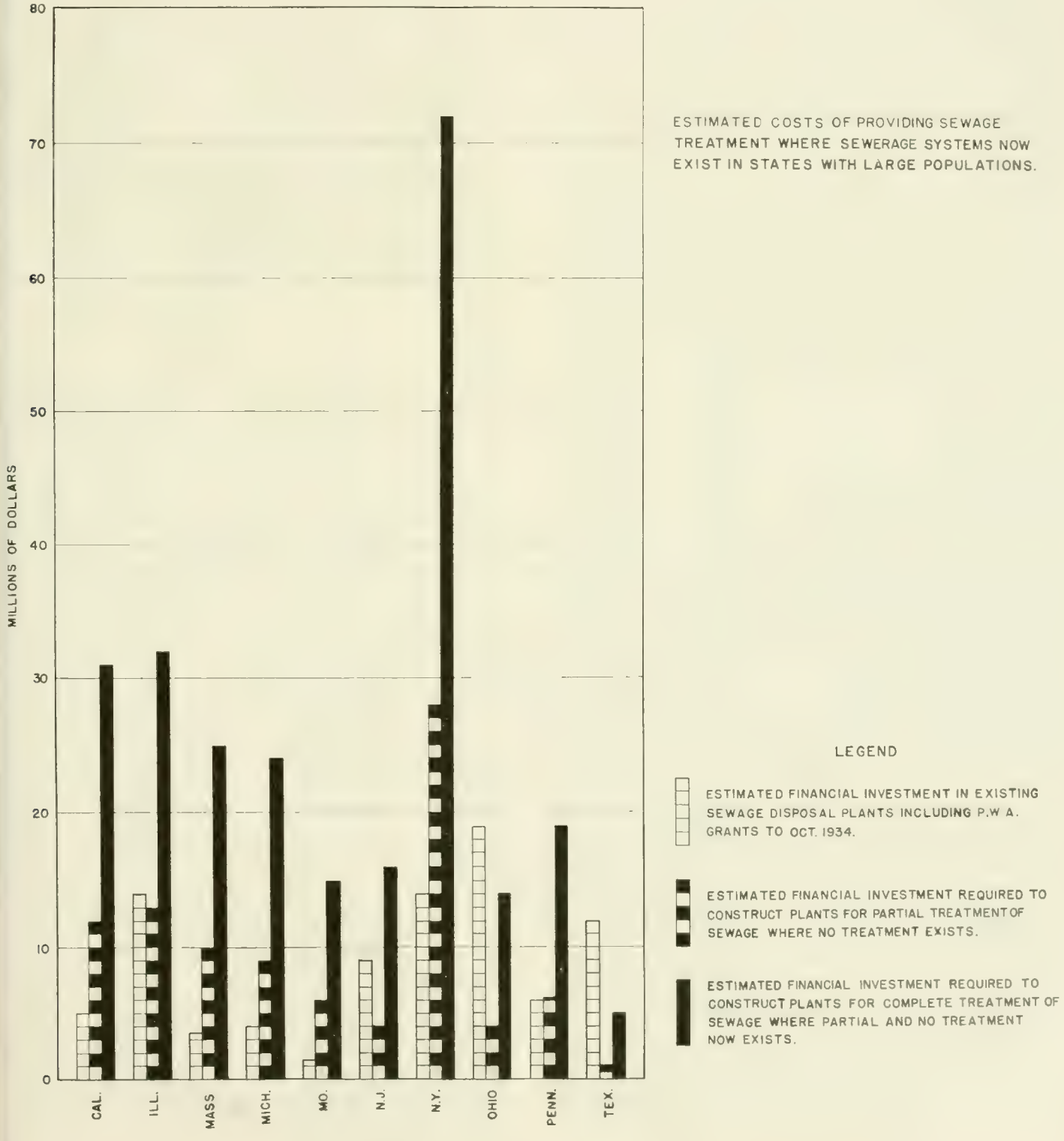


in most cases the volume of the diluting waters into which the wastes have been deposited has been sufficient to prevent serious nuisances, but the damage to these waters is diminishing their use as sources of public water supply and depreciating their value for industrial and recreational purposes. While many of the small rivers and streams are grossly contaminated by sewage and industrial wastes, considerable progress has been made toward their restoration.

In New England there is a variety of industries. Textile and paper mills largely predominate, although tanneries, metal industries, and other widely diversified manufacturing are developed rather extensively in these States. It is reported that relatively few sources of domestic water supply are seriously contaminated by untreated sewage. Probably the greatest damage has been that suffered by the industries, particularly the textile and paper industry, where process water of superior physical quality is of primary importance. As to the recreational uses and depreciation of waters for the support of fish life, considerable damage has already occurred in certain areas. This is particularly the case in the streams in northern New England and in certain areas in New York and Pennsylvania where streams are receiving fairly large amounts of industrial wastes from paper industries, tanneries, mine drainage, etc.

The Merrimac, Penobscot, Connecticut, Mohawk, and Hudson Rivers are all heavily polluted for considerable distances above their mouths. New York Harbor and the waters in its vicinity have reached a state of gross pollution which has been a scandal for years.

The Delaware River and the contributing larger rivers, the Lehigh and Schuylkill, are all grossly polluted although an effort has been made by the Sanitary Water Board of Pennsylvania to control further contamination of these streams. All these water courses receive large volumes of domestic and industrial wastes, and the Lehigh and Schuylkill are contaminated also by coal mine drainage. The aggregate pollution discharged into the Susquehanna River is also extensive.

The larger cities situated on the Atlantic seaboard generally empty their sewage into the tidal waters. Where the discharge of the wastes has been effected by distribution through multiple outlets and at sufficient distances from the shore line, this means of disposal has been relatively satisfactory. In other cases partial removal of suspended solids with or without chemical sterilization has proven adequate for the existing conditions. The latter type of treatment has been required where the volume of dilution water has not been sufficient to inhibit nuisances.

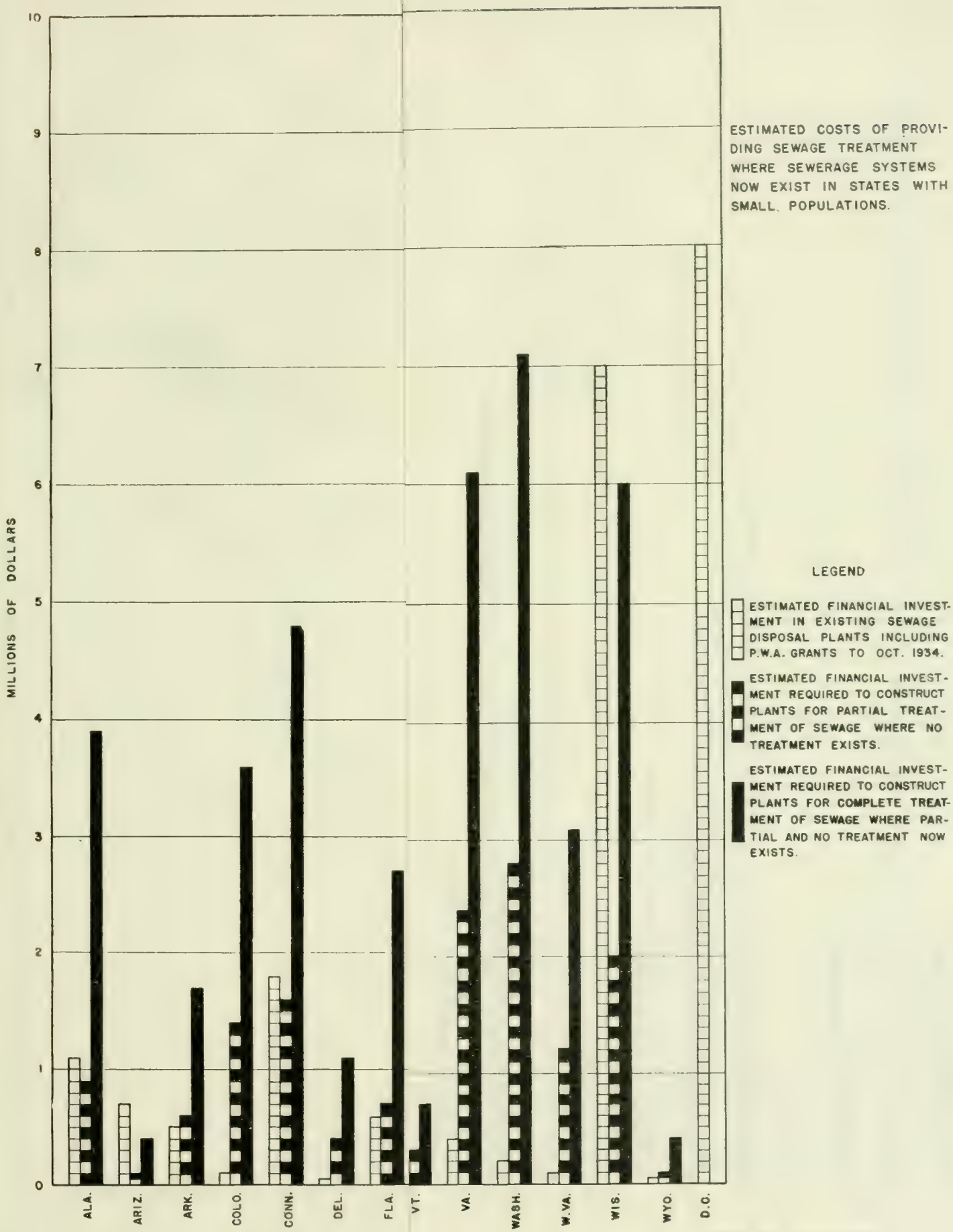
The pollution from the various coastal cities varies considerably. Boston Harbor is only moderately polluted, and the most serious losses that have resulted from contamination of these waters is the condemnation of certain shellfish areas. Much objection from an aesthetic viewpoint has been raised, however, to the form of sewage disposal.

In the New York metropolitan area, the diversity and magnitude of manufacture is probably greater than in any other similar district in the world; its influence is so wide-spread that its problems are of national importance. These waters are very heavily polluted by both sewage and industrial wastes over an extensive area, and material damage has resulted to industrial consumers of water and to the shellfish industry. Recreational utility of the beaches has also been impaired. The problem is acute and it is realized that further increase of the pollution load of New York Harbor and adjacent waters cannot be permitted without disastrous results. The States of New York, New Jersey, and Connecticut have taken cognizance of the magnitude of the problem, and have appointed a research and engineering committee to facilitate the drafting of a Tri-State Treaty to bring about the abatement of pollution of the harbor and coastal waters within the metropolitan area.

South Atlantic and Eastern Gulf Drainage

On the whole, this region is characterized by small towns with modern sewage treatment plants, and the most backward communities, in this respect, are the older coastal cities of declining commercial importance. This is borne out by the accompanying map which indicates that the coastal towns, as in the North Atlantic area, are depending on dilution or partial treatment for the disposal of domestic sewage. Pollution of shellfish and bathing areas by sewage is of special concern. Shellfish areas are under strict surveillance of the United States Public Health Service, and marketing restrictions are enforced to protect consumers. Important oyster beds in the Chesapeake Bay have been condemned as sources of marketable shellfish. Measures to correct gross pollution at Washington, D. C., Cambridge, Md., and Annapolis, Md., are contemplated. Large amounts of raw sewage are discharged into tidal waters at Norfolk, Savannah, Jacksonville, Miami, Miami Beach, Pensacola, and Mobile.

The district is industrialized to a moderate extent. The areas of greatest density are the James and Roanoke Valleys, with tanneries, rayon mills, and other industries; the textile centers in the Carolinas; and the iron and coal region around Birmingham. The principal harmful effect of trade waste in the Coastal Plain will probably be confined to destruction of fish life and odor nuisance. In the upper reaches, the effect of many trade wastes is to check the normal biological processes in the flowing streams, resulting in destruction of fish life, odors, and general impairment from recreational and scenic standpoints.



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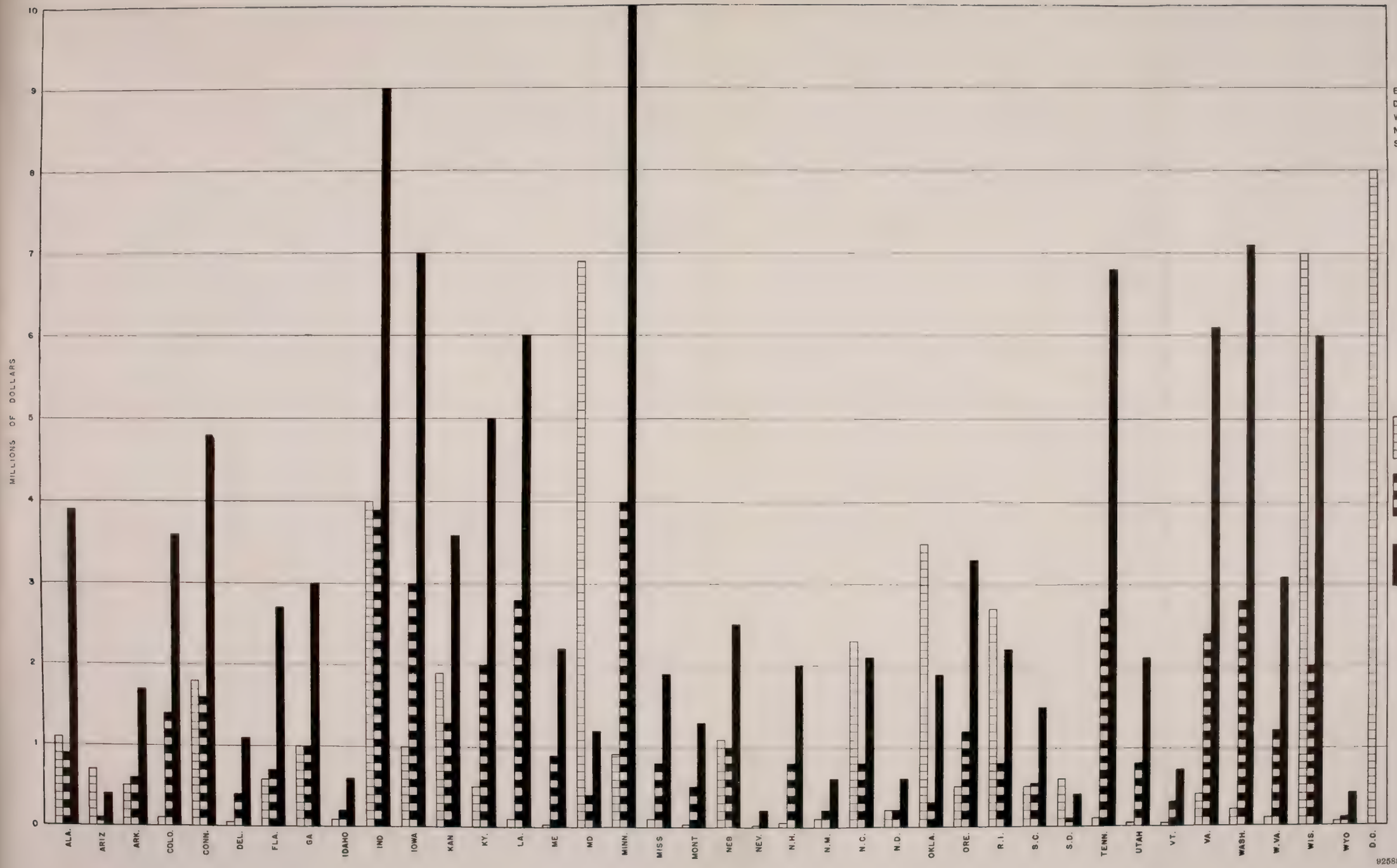

ESTIMATED COSTS OF PROVIDING SEWAGE TREATMENT WHERE SEWERAGE SYSTEMS NOW EXIST IN STATES WITH SMALL POPULATIONS.

LEGEND

ESTIMATED FINANCIAL INVESTMENT IN EXISTING SEWAGE DISPOSAL PLANTS INCLUDING P.W.A. GRANTS TO OCT. 1934.

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ESTIMATED FINANCIAL INVESTMENT REQUIRED TO CONSTRUCT PLANTS FOR COMPLETE TREATMENT OF SEWAGE WHERE PARTIAL AND NO TREATMENT NOW EXISTS

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NATIONAL RESOURCES BOARD
WATER RESOURCES SECTION
LOCATION OF
POLLUTION OF SURFACE WATERS
BY
INDUSTRIAL WASTES
AND
MINE DRAINAGE
LEGEND
By Industrial Wastes
By Mine Drainage

Great Lakes and St. Lawrence

In general, the Great Lakes have been used extensively by bordering cities for disposal of raw or partially treated sewage. The larger cities thus contributing to pollution are Buffalo, Lorain, Toledo, Detroit, Port Huron, Muskegon, part of the Chicago area, Racine, Sheboygan, Green Bay, and Duluth. In addition, the streams which are tributary to the Lakes receive sewage from many communities. Because of the abundance of surface water affording large dilution, sewage treatment has not been extensively developed in this area.

The urgent need for adequate disposal of sewage from the Chicago sanitary district, and the United States Supreme Court order restricting further withdrawal of water from Lake Michigan for dilution purposes, have necessitated a comprehensive sewage-treatment program in this area. Milwaukee, Cleveland, Rochester, and other communities have installed complete treatment plants.

Pollution on the Red River is quite serious throughout its length and became aggravated greatly during the drought of the last few years. The St. Louis River is heavily polluted, but the remainder of the streams in northern Minnesota are largely in a state of natural purity.

The Fox, Milwaukee, Chicago, Calumet, and Maumee Rivers are lined with industrial plants and so contaminated that usefulness for any other purpose is destroyed. In addition, the large cities are centers of intense and diverse industrial development. Among the major waste problems are: Wood pulp, tanneries, canneries, and creameries in Wisconsin and Michigan; meat packing, corn products, tanneries, paint, and chemicals in Chicago; coke and steel mills around the southern tip of Lake Michigan and the southern shore of Lake Erie.

This region is very highly industrialized, and the sewage and trade-waste disposal problems will continue to increase in magnitude, particularly as more and more demands are made for clean streams and lakes for water supply, swimming, and recreational uses.

The Mississippi Valley

The several basins in this great area will be discussed individually.

The upper Mississippi River is lined with towns and cities, notably Minneapolis and St. Paul, that empty their untreated sewage into this stream. In August of 1926 the Mississippi was so overloaded with impurities that the dissolved oxygen was reduced to about 10 percent of its normal content from Minneapolis to a point 45 miles downstream. Several large tributaries which carry domestic sewage, particularly the Illinois River, with the untreated sewage of Chicago, enter the Mississippi River above St. Louis. Until recently the latter city obtained all of its water supply from this river but now receives a considerable quantity from the Missouri River.

An enormous amount of trade waste is contributed to the upper Mississippi River Valley by the creameries, canneries, pulp and paper mills, and slaughtering and poultry-dressing establishments which have located in this populous area. The Chippewa, Black, Wisconsin, Rock, Des Moines, and Illinois Rivers carry large quantities of industrial wastes. The seriousness of the stream-pollution problem in this highly industrialized area is probably as great as in any other section of the United States.

The lower Mississippi River receives large contributions of water from the Missouri, Ohio, and Arkansas Rivers. Moreover, a fairly large number of sewage-treatment plants have been built in this region, and stream pollution is not a serious problem at present.

The industrial wastes of this region are very scattered, consisting principally of oil and brine from the oil fields of Kansas and Oklahoma, beet sugar wastes along the upper reaches of the Arkansas River in Colorado, and packing house waste at Oklahoma City. Shaft mines in this region usually do not have mine drainage pollution.

The Missouri River receives the raw sewage of many towns along its great length, notably in Montana and at Kansas City, Omaha, and Sioux City. Denver discharges its untreated sewage into the upper branches of the South Platte River, causing a serious pollution problem.

Industrial pollution within the valley is concentrated at St. Louis, Kansas City, and some centers in Nebraska, consisting principally of trade wastes from packing houses, breweries, paint and chemical plants, canneries, and beet sugar refineries.

The Ohio River Basin has a population of about 20 million, with a high percentage living in large towns and cities. The Ohio River itself carries by far the greatest amount of pollution of any stream in the basin, receiving the raw sewage from Pittsburgh, Wheeling, Huntington, Cincinnati, Louisville, Evansville, and other communities. Most of these cities have serious nuisances downstream from their sewage outlets during the dry months of every year. Elsewhere in the region, Terre Haute on the Wabash, Nashville on the Cumberland, and Knoxville on the upper branches of the Tennessee use these adjacent rivers to receive their untreated sewage. Several complete treatment plants have been constructed in this basin, notably at Indianapolis and Columbus, and many more should be undertaken to eliminate the contamination of the waters of these major rivers.

The many industrial wastes of the Ohio Basin are greatly diversified, having their greatest concentration

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around the Pittsburgh area. Mine drainage on the Monogahela River neutralizes the natural alkalinity of the water and causes an acid condition during the greater part of the year and over most of its length. The Allegheny, at the intake of the water supply for Pittsburgh, has been acid during periods of low stream flow for the past 7 years. The section on "quality of surface and ground waters" covers this important aspect of pollution.

Other major sources of industrial waste in the Pittsburgh area are the steel mills, chemical plants, tanneries, and distilleries, The paper industry on the headwaters of the Ohio contributes large volumes of waste to the streams. Notable investigations of fundamental factors in water pollution have been made on the Ohio River by the United States Public Health Service.

The Muskingum, Scioto, Miami, and Wabash contribute more pollution to the Ohio River than it receives from the many industries along its own banks. It has been estimated that the oxygen-consuming requirements of the industrial wastes of the Ohio Valley is equal to twice that required by sewage.

The Cumberland and Tennessee Rivers are relatively free from industrial waste except at a few localized points

Southwest and Western Gulf

Under the compulsion of laws of Texas and New Mexico, which prohibit the discharge of insufficiently treated sewage into streams, almost all of the communities of this section have built treatment plants. The accompanying map shows a very high percentage of sewage treatment as compared with other drainage basins. However, in the more densely populated eastern half more attention to sewage treatment will soon be required. The Trinity River, from Fort Worth to a point several miles below Dallas, is mentioned as badly polluted in dry months. In the drier western section, the health departments approve of the use of settled sewage for irrigation.

In general, because of the moderate density of industrial development, the southwest and western Gulf region is relatively free from industrial-waste problems. The chief offenders are cotton-mill waste on the Trinity River, which causes serious pollution during dry months, and oil and salt water from the oil fields. Industrial plants at Beaumont, Port Arthur, and Houston contribute fairly large quantities of contamination, and there is now some agitation for adequate control measures. Shellfish areas are not seriously affected, and recreation resorts are free from pollution.

Colorado River Basin

It appears that the Colorado River Basin has almost no waste-disposal problems. Only three communities of any magnitude dispose of their raw sewage by dilution. The stream flow at these places is usually adequate for this form of treatment. All other cities and towns have provided some form of sewage treatment. Mining is the only industry of any significance, and industrial wastes are unimportant.

South Pacific and The Great Basin

The locations having greatest sewage pollution are the Sacramento and San Joaquin Valleys, San Francisco Bay, and the Los Angeles district. At the two latter places, there is impairment of water quality for swimming and recreational uses. Fishermen claim damage because their nets are filled by the garbage which Oakland dumps outside San Francisco Harbor. Smaller communities around Los Angeles have quite complete treatment. Fresno disposes of its sewage by irrigation, which should cause no stream-pollution problem; however, waterfowl have become diseased from raw sewage discharged into lagoons in the San Joaquin Valley. In the northeast corner of this area several large cities empty untreated sewage into Great Salt Lake.

California has numerous industries with wastes of a serious nature, such as canneries, tanneries, wineries, and lumber mills. However, steps have been taken to protect fish life, and grave pollution from industrial waste does not exist. The oil nuisance is the greatest industrial source of coastal pollution, and many separating and reclaiming stations have been installed. The most important waste problems on the inland streams of this region are the copper mines at Bingham Creek, Utah, and Plumas County, Calif. Placer mining on the mountain streams affects the water supplies of several communities.

In this territory no serious nuisances have been created by sewage discharge into tidal waters, but recreational values are somewhat impaired on the Rogue and Umpqua Rivers and at Lake Washington. Modern treatment is not well developed in this area, and such large centers as Portland, Tacoma, and Seattle empty their sewage into surface waters. In the sparsely populated interior, pollution occurs only at isolated spots.

Most of the industry is concentrated around the seacoast towns. Pulp and paper mills, and canneries, are affecting the lower Willamette River in Oregon to such an extent that there is no dissolved oxygen at the mouth of the river at certain times. It is reported that these wastes account for half of the oxygen-consuming impurities in this river.

This condition is highly inimical to fish life, including the salmon, which supports an important industry in this territory.

Summary

1. There is an apparent deficiency of reliable information concerning certain areas, and this indicates the necessity of further study before the existing needs can be properly determined.

2. There are obvious centers of gross pollution which require remedial measures immediately.

3. The discharge of excessive quantities of industrial waste and of mine drainage in many industrial centers is resulting in rapid depreciation of surface waters, destroying the value of these resources for domestic, industrial, and recreational use.

4. Interstate problems are acute in water-pollution control as in other elements of water conservation.

5. More effective action is justified by regulatory bodies to encourage reduction of industrial-waste pollution by economic recovery measures, and to require more adequate and widespread treatment of domestic sewage.

SECTION II
X. DRAINAGE

Land drainage as affecting national policy governing water resources needs consideration from two aspects: (1) the effect of land drainage on surface run-off; and (2) the extent to which provision for land drainage should govern a water policy.

I. Drainage and Run-off

The valley of the Red River of the North furnishes the principal data in respect to the first aspect of this subject. In 1921 a complaint in equity against Minnesota by North Dakota, made on behalf of certain citizens, was argued before the Supreme Court of the United States. It was alleged that damages had resulted from excessive flooding caused by drainage works in the valley of the Red River. The Court (U. S. Repts., vol. 263, October series 1923, p. 365) dismissed the case without prejudice, holding that the plaintiff State had not proved its case and that a cycle of years of high rainfall might have been the cause. The opinion of qualified observers is divided, and so many factors determine whether or not the flow-regulation provided by the flat lowlands of the Red River is impaired by their drainage that no general statement is practicable.

A detailed study of the effect of land drainage upon flood run-off in Iowa has been made by Woodward and Nagle. No relation was discovered.

Studies of such relations are few, incomplete, and of local significance. A change in vegetative cover may have large effect. Marshes or swamps underlain by deep, decomposed vegetable matter commonly maintain their spongy nature through wet and dry periods while undisturbed, but settle and become much less porous when drained. Much less alteration results from the drainage of alluvial swamps. When soil absorption capacity reaches a minimum, virtually all surface water runs off. Collecting ditches decrease its time of detention.

II. Water-Use Policy

The weight to be given drainage in the formulation of a water policy probably will depend in part on its economic purpose and value under the following classifications: (*a*) Land reclamation, and (*b*) mosquito control.

(*a*) Land reclamation through drainage includes (*i*) the improvement of land already in farms, and (of similar nature), (*ii*) the removal of excess water and alkali resulting from irrigation; and (*iii*) reclamation of marsh or swamp land not previously in farms. The total area in drainage enterprises in the United States by 1930 was 34,403,093 acres. The reclamation of marshes and swamps involved 27 percent and the improvement of lands already in farms involved 63 percent of the total area.

(*b*) Mosquito control includes (*i*) malarial control in the interest of public health, and (*ii*) nuisance abatement, whether for the improvement of land values, the conditions of labor, or the conditions of recreation.

III. Regional Summaries

In the following review by regions, the figures in parentheses indicate the percentages of the total area of drained lands in the United States that are found in the respective regions.

1. *North Pacific Drainage* (1 percent): On the humid Pacific slope, drainage projects reclaim swamps and overflowed lands; in the arid or semiarid interior, their purpose is to lower the seepage-water plane in irrigated lands or to improve overflowed lands on lake borders. Mosquito control is not an independent problem.

2. *South Pacific and Great Basin Drainage* (4 percent): Existing projects include tidal-marsh reclamation in the San Francisco district, agricultural reclamation of upland lake-beds, and flood-plain reclamation by means of protecting levees with gravity or pumped drainage systems behind them. Drainage through intensive pumping of underground water for irrigation is very extensive in this region; it has pioneered in works to spread surface floods over alluvial cones to increase water storage and to check the flooding of lowlands.

3. *Colorado Basin* (9.5 percent): All drainage projects in this basin are for lowering seepage and alkali on the larger irrigation projects. There is no drainage for mosquito control, and there are no malarial mosquitoes

4. *Western Gulf Drainage* (5 percent): About 6 percent of the drainage in this region is to lower seepage on irrigation projects in the uplands. The remainder is principally in the lower coastal plain. About three-quarters of the latter is reported as for the improvement of lands already in farms; the balance is for the reclamation of swamps.

Malaria is prevalent in the lowlands, and extends into higher altitudes only in the Rio Grande Valley. It has been suggested that clean-up for mosquito control on existing drainage systems appears a desirable form of emergency relief employment, but that it is not justifiable in areas not already drained.

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Typhoid Fever and Malaria Death Rates in the United States

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5. *Mississippi Basin* (53 percent): Drainage projects are of all types. In the alluvial lands of the southern delta region, including the St. Francis, Yazoo, and Atchafalaya Basins, swamp reclamation was the chief purpose. In the glacial plains of southern Minnesota, Iowa, Illinois, Indiana, and Ohio, settlement occurred early, and drainage districts supplemented individual works to improve occupied farms. Along the bottom lands of the Mississippi, Illinois, Wabash, Red, Kansas, and other rivers, drainage accompanies the protection by levees of river bottoms. In the irrigated semiarid lands of the western headwaters, the removal of seepage water and alkali is the purpose.

Malaria is a problem of public health only from southern Illinois southward; the recent unemployment-relief organizations have done much effective work in the southern parts of the basin.

6. *Red River and Great Lakes Drainage* (28 percent). In northern Ohio and Indiana, parts of Michigan, and parts of the Red River Valley, the nearly level and poorly drained beds of glacial lakes were generally drained for the improvement of lands already in farms. In northern Michigan and in Minnesota and Wisconsin, swamps and marshes abounded in shallow depressions in the surface of the glacial drift. Their drainage in most cases was for the reclamation of uncultivated land. Much of it was cut-over timberland which has not proven suitable for agriculture. Drainage for mosquito control alone is not practiced in this region; malaria is not a problem.

7. *North Atlantic Drainage:* In the northeastern States, including New York, Pennsylvania, New Jersey, and Delaware, there are few drainage districts for land reclamation; topography and soil make little agricultural drainage necessary. Aviation fields have been the principal projects reclaiming wet land, as in the Neponset River meadows near Boston.

The drainage through local agencies of coastal salt marshes for abatement of the mosquito nuisance has been carried on successfully for years past, from Cape Cod to Cape May. During the past year work of this type has been extended greatly in connection with State and Federal unemployment-relief projects. These included notably satisfactory projects in Delaware and Massachusetts.

8. *Eastern Gulf and South Atlantic Drainage* (9 percent): Drainage in the coastal plain has generally been speculative, and based on the hope of converting marshland or wet cut-over swamp land into salable farm land. By far the largest undertaking is that represented by the 2,300,000 acre Everglades Drainage District in Florida. The relatively small drainage projects in the wet meadows of the upland creeks of the piedmont were, in most cases, undertaken to improve land already in farms, and many of them were stimulated by the help of the International Health Board in its campaign for malaria reduction. Most of the large lowland projects proved premature and economically unsound. The upland projects demonstrated their value in improved public health until lack of maintenance and siltage in stream channels restored conditions favoring mosquito breeding. Much Federal unemployment-relief work has been done recently for malaria control in this region.

IV. Some Drainage Problems

From the standpoint of drainage, it appears that where wet lands are flooded by waters of interstate origin, a clarification and a harmonization of national and State policies are desirable. In connection with such a development, a classification of projects appears necessary. The accompanying table is believed to reflect the relative lack of success, financially, of speculative projects for the reclamation of swamp lands. General experience with such projects has shown that two successive groups of owners are ruined in their efforts to "tame" the land, and that the third group of owners may succeed by benefit from the losses of their predecessors. Regional reports mention lake-drainage projects in States as widely separated as California, Wisconsin, and North Carolina which, admittedly, are failures for lack of adaptation to agriculture; projects on which it is believed to be desirable to restore the former water levels to achieve the best economic use of the areas. Little regard in a national water policy should be given to potential drainage projects whose economic soundness and justification within a reasonable time are not clearly demonstrable.

Drainage for the prevention of malaria has a well-established technique; the transmission of the disease has been traced to a night-biting mosquito whose breeding habits have been learned, and methods to prevent its production, largely by drainage, are known. Together with house-screening and medical elimination of the acute disease from infected persons who serve as malaria carriers, such drainage is of high economic value in settled areas. It must follow a special technique and usually must supplement drainage for land reclamation.

Drainage for abatement of pest varieties of mosquitoes, not involving public-health consideration, also has a special technique. Generally only very shallow lowering of the ground-water horizon is necessary, or economically justifiable. The preservation of area values for wildlife refuge and breeding is in many cases a major economic consideration, too often overlooked by inexperienced designers. Well-constructed projects have proven of high economic value, through increased values of residential property, increased field-worker efficiency, and increased milk yield of dairy herds.

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IV. Some Drainage Problems

From the standpoint of drainage, it appears that where wet lands are flooded by waters of interstate origin, a clarification and a harmonization of national and State policies are desirable. In connection with such a development, a classification of projects appears necessary. The accompanying table is believed to reflect the relative lack of success, financially, of speculative projects for the reclamation of swamp lands. General experience with such projects has shown that two successive groups of owners are ruined in their efforts to "tame" the land, and that the third group of owners may succeed by benefit from the losses of their predecessors. Regional reports mention lake-drainage projects in States as widely separated as California, Wisconsin, and North Carolina which, admittedly, are failures for lack of adaptation to agriculture; projects on which it is believed to be desirable to restore the former water levels to achieve the best economic use of the areas. Little regard in a national water policy should be given to potential drainage projects whose economic soundness and justification within a reasonable time are not clearly demonstrable.

Drainage for the prevention of malaria has a well-established technique; the transmission of the disease has been traced to a night-biting mosquito whose breeding habits have been learned, and methods to prevent its production, largely by drainage, are known. Together with house-screening and medical elimination of the acute disease from infected persons who serve as malaria carriers, such drainage is of high economic value in settled areas. It must follow a special technique and usually must supplement drainage for land reclamation.

Drainage for abatement of pest varieties of mosquitoes, not involving public-health consideration, also has a special technique. Generally only very shallow lowering of the ground-water horizon is necessary, or economically justifiable. The preservation of area values for wildlife refuge and breeding is in many cases a major economic consideration, too often overlooked by inexperienced designers. Well-constructed projects have proven of high economic value, through increased values of residential property, increased field-worker efficiency, and increased milk yield of dairy herds.

Drainage statistics by States from Fifteenth Census of the United States, 1930, showing total acres in drainage enterprises, and, successively, percentages of area (a) *delinquent in drainage taxes,* (b) *unimproved, and* (c) *idle*

NORTH ATLANTIC DRAINAGE *

[New England, New York, Pennsylvania, New Jersey, Delaware: No drainage districts]

SOUTH ATLANTIC AND EASTERN GULF DRAINAGE

Drainage prevailing for reclamation of wet land

	Total acres	(a)	(b)	(c)
Virginia	15,042	0.6	59.8	63.1
North Carolina	679,236	14.5	55.0	53.4
South Carolina	208,249	37.0	63.7	60.5
Georgia	84,255	41.1	46.6	41.6
Florida	5,954,934	51.2	86.9	92.4

MISSISSIPPI RIVER DRAINAGE

First Group: Drainage prevailingly for improvement of land in farms

Ohio	8,165,494	0.3	6.8	4.4
Indiana	10,214,014	.9	8.3	4.7
Illinois	5,032,682	2.0	5.6	4.6
Iowa	6,137,649	3.4	2.8	1.2
South Dakota	697,758	5.3	5.1	7.4
North Dakota	1,094,142	.2	1.7	9.4
Nebraska	879,459	1.5	5.2	5.2
Kansas	257,169	.1	3.4	1.2
Oklahoma	170,158	4.2	16.1	15.3

Second Group: Drainage prevailingly for reclamation of wet land

Missouri	3,150,022	30.1	26.7	27.9
Kentucky	585,625	10.0	23.9	38.0
Arkansas	4,631,155	22.0	43.5	43.9
Tennessee	593,560	38.1	51.7	54.6
Mississippi	2,988,496	4.6	34.7	32.6

Third Group: Drainage prevailingly in connection with irrigation projects

Montana	167,629	4.0	11.2	10.8
Wyoming	245,703	8.5	26.0	26.2
Colorado	366,719	6.5	17.6	19.0

* Land drainage enterprises in Mississippi are principally outside this area.

Drainage statistics by States from Fifteenth Census of the United States, 1930, showing total acres in drainage enterprises, and, successively, percentages of area (a) *delinquent in drainage taxes,* (b) *unimproved, and* (c) *idle*—Continued

GREAT LAKES AND RED RIVER DRAINAGE

Drainage prevailingly for reclamation of wet land

	Total acres	(a)	(b)	(c)
Michigan	9,180,851	3.5	16.5	11.0
Wisconsin	892,713	27.0	40.4	42.4
Minnesota	11,474,683	26.2	35.5	32.6

NORTHWEST PACIFIC DRAINAGE

Drainage projects partly for swamp land reclamation and partly in connection with irrigation projects

Idaho	375,464	3.3	5.5	7.5
Washington	367,242	4.8	9.5	9.2
Oregon	211,182	33.2	31.7	24.8

SOUTHWEST PACIFIC AND GREAT BASIN DRAINAGE

Drainage prevailingly for reclamation of wet land

California	2,233,714	9.4	11.0	16.1
Nevada	162,980	4.5	24.5	27.8
Utah	156,052	62.9	11.5	39.0

COLORADO RIVER DRAINAGE

Drainage in connection with irrigation projects

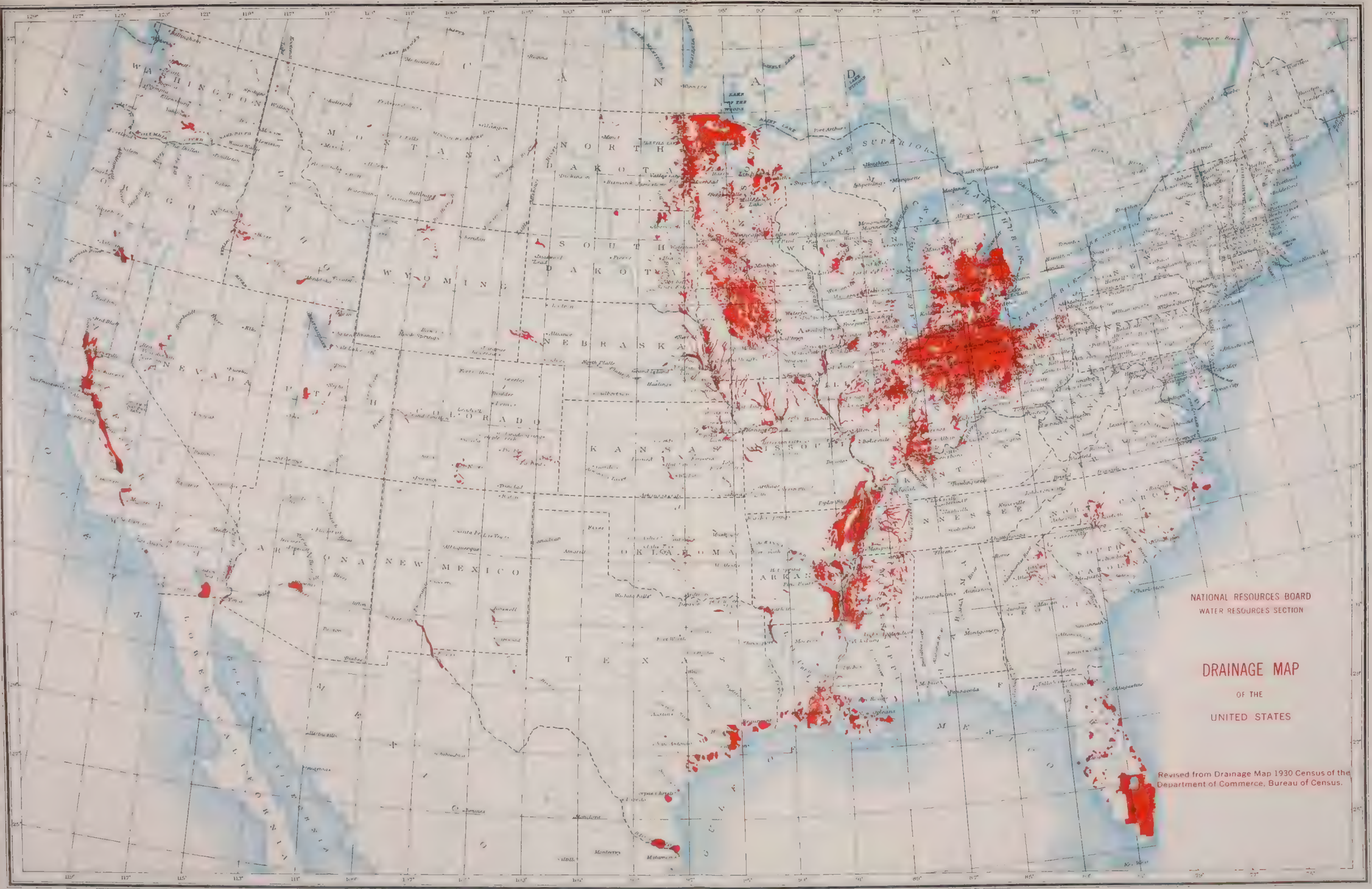
Arizona	318,931	1.1	30.8	12.3

SOUTHWEST AND WESTERN GULF DRAINAGE

Drainage prevailingly for reclamation of wet land

Texas	2,883,356	9.8	30.5	28.3
New Mexico	176,292	11.4	16.8	17.5
Louisiana[1]	3,655,483	4.3	37.9	36.8

[1] Part of this reclaimed area lies within the Mississippi Basin, but the larger portion is in the Gulf drainage area; the State is therefore listed within the latter arc.


NATIONAL RESOURCES BOARD
WATER RESOURCES SECTION
DRAINAGE MAP
OF THE
UNITED STATES
Revised from Drainage Map 1930 Census of the Department of Commerce, Bureau of Census.
Land in drainage enterprises shown in red
Scale of Miles

SECTION II
XI. IRRIGATION

There are few localities in the United States where the precipitation is so abundant and so well distributed throughout the year as to meet satisfactorily the water requirements of all crops otherwise suited to them. Accordingly, irrigation is practiced to greater or less extent in virtually all parts of the country.

In the eastern, central, and southern States, irrigation is practically limited to flowers and lawns, garden truck, fruits, and the like. Generally, domestic water supplies are used, although supplemental irrigation from other sources is increasing rapidly.

West of the Mississippi, and particularly west of the lower Missouri, the draft on town and city water supplies thus utilized begins to be significant; in this region, also, the inevitable hazard of periods of low rainfall is taken more or less into consideration in the selection of unirrigated crops. The cost of irrigation for general farming is not warranted in most districts and the supply of water available for the purpose is restricted.

Before the eastern foothills of the Continental Divide are reached there are scattered irrigation systems for field crops, and to an increasing extent commercial truck gardens and those attached to farm homes are watered artificially.

In the truly arid region farther west, irrigation generally is the price of agricultural settlement, and full land use is impossible without it. Except for the numerous irrigated areas and artificial water holes, even grazing would be limited to favored districts. Various irrigation enterprises made possible the growth of entire civilizations and constitute their chief support. Examples are those in the neighborhood of Salt Lake City, Boise, Albuquerque, and Phoenix, and those in southern California. In many districts the limits of ultimate development are exactly those fixed by the available water supply. All the districts named have already utilized fully the local water supplies, and are seeking new supplies from more or less remote sources at costs undreamed of 20 years ago.

In general, there are very few entirely undeveloped irrigation opportunities. Few irrigated areas have attained their maximum possible development, however, though most of them have been expanded well beyond their present water supply provisions.

The irrigated and irrigable acreages of the West, segregated by major drainage basins, are estimated as follows:

District	Irrigated (acres) (1929)	Total area susceptible of irrigation (acres)
North Pacific	3,632,000	10,155,000
South Pacific and Great Basin	6,017,000	18,107,000
Colorado River	2,537,000	7,323,000
Western Gulf	1,787,000	3,567,000
Southwest Mississippi	740,000	1,742,000
Missouri Basin	4,228,000	10,565,000
Total	18,941,000	51,459,000

The foregoing data may be misleading in that lands to which water is applied only once or twice a year are classed with lands such as those in the Imperial Valley, where not even weeds grow naturally, where domestic and stock water must come from the irrigation canals, and where the minimum water use on New Year's Day is one-third that in mid-summer. Further segregation of the data might complicate matters, however, to the point of confusion.

Some 16 million acres are irrigated from surface waters, about 2,000,000 acres from underground waters, and about 2,000,000 acres from a combination of the two. In other words, something on the order of 15 percent of the irrigated acreage is served by underground waters. This indicates a surprisingly important use of such waters, concerning which data are much more meager than those relating to surface waters. The relative importance of underground waters in irrigation is even greater, however, than the figures indicate, since irrigation from subsurface sources is usually on lands of high value.

Often the drafts on underground supplies are in excess of replenishment by rainfall or otherwise, and it is quite probable that in many districts the aggregate use of such waters already has reached its maximum. By far the greatest lack of essential water-resource data in the arid and semiarid States is concerned with ground waters, and the need for more information concerning them is urgent.

About one-third of the total irrigated area in the United States is in enterprises so small that they are classified as individual or partnership. Another third is in cooperative enterprises, some of them large but most of them small. Most areas of these two types, totalling two-thirds of those irrigated in the entire country, are served by irrigation works which never have had any bonded indebtedness.

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About one-third of the total irrigated area in the United States is in enterprises so small that they are classified as individual or partnership. Another third is in cooperative enterprises, some of them large but most of them small. Most areas of these two types, totalling two-thirds of those irrigated in the entire country, are served by irrigation works which never have had any bonded indebtedness.

Irrigation districts and water users' associations control a large percentage of the remaining irrigated area, or approximately 25 percent of the total. These organizations have power to levy taxes or assessments, or both, and are able to create large indebtedness. About two-thirds of the lands watered by canal systems that were constructed by the Bureau of Reclamation come within this category. The management of these districts and associations is by elected officers.

The remaining irrigated area (less than 10 percent) are mostly within projects now under direct control of the United States Bureau of Reclamation or the Bureau of Indian Affairs. It should be noted, however, that Federal agencies also supply stored water to certain areas which never were included in Government projects, areas totalling nearly 7.5 percent of the Nation's irrigated lands. This service is of greater importance than the figures might signify, because on the areas so assisted the need for such conserved waters was very pressing.

The lands now irrigated and ultimately irrigable, in the arid and semiarid States, are estimated as follows in percentages of the total land areas of those States:

States	Total area of State (square miles)	Percent of total area now irrigated	Percent of total area probably ultimately irrigated
Arizona	113,956	0.8	4.8
California	158,297	4.8	16.9
Colorado	103,948	5.1	7.55
Idaho	83,888	4.1	6.74
Kansas	82,158	.1	2.58
Montana	146,997	1.7	3.97
Nebraska	77,520	1.1	3.31
Nevada	110,690	.7	1.37
New Mexico	122,634	.7	1.72
North Dakota	70,837	.02	.82
Oklahoma	70,057	.004	.22
Oregon	96,699	1.47	4.94
South Dakota	77,615	.14	.56
Texas	265,896	.48	1.55
Utah	84,990	2.5	4.06
Washington	69,127	1.1	5.9
Wyoming	97,914	2.0	6.62
Total		1.63	4.58

In spite of these strikingly small percentages, the stage has been reached very generally where the outstanding need is for further water storage, so that the flow of streams can be regulated to meet irrigation needs and the run-off during periods of excessive precipitation can be held back for use during dry years.

Over the arid and semiarid section of the country, water requirements of irrigated land probably average at least 2 acre-feet per acre per annum. Probably 85 percent of the ultimate total of irrigable lands, now estimated at about 50 million acres, will be served by surface waters. In that case, the total annual draft on surface waters would approximate 85 million acre-feet, and the storage would be on the order of 175 million acre-feet. Including all works now under construction the total reservoir capacity of the arid and semiarid parts of the United States is about 86 million acre-feet, or half that which ultimately may be needed.

The additional storage that may be required will be more expensive than that already provided, and in many cases there cannot be piecemeal construction. From now on, most additional units may be so large, complicated, and expensive as to suggest that the Federal Government advance the initial costs. If carefully selected and planned, such storage projects should all be self-liquidating.

Next to storage, the outstanding need in the field of irrigation is the limitation of areas to their available water supplies. Overexpansion of the irrigated acreage almost inevitably occurs, during a series of relatively wet years, with serious losses, troublesome litigations, and urgent appeals for State and Federal assistance during the next ensuing period of dry years. Emergency measures for increasing or reallocating the available water during critical periods of drought become imperative, else large numbers of people suffer great losses.

Another need of importance, somewhat less general, is that of consolidating many small irrigation organizations in a given neighborhood or on a given stream into one organization in which a complexity of water rights will be pooled. This procedure would simplify administration, reduce costs of operation, and eliminate much litigation otherwise resulting from attempts to preserve the priority of individual water rights.

Long-time planning for irrigation should begin with an appraisal of water resources and a determination of the total areas which can be adequately watered year in and year out. The necessity for long-time planning for irrigation in the arid sections of the United States may be expressed briefly as follows:

The existence and growth of successful agriculture is largely dependent upon irrigation. Most water not required for the primary needs of human consumption will ultimately be used for irrigation. In connection with the use of irrigation waters, treatment of sewage from irrigated areas should be given consideration.

Most natural stream flow and readily available underground water already has been put to use for irrigation and often delivery has been made to areas too large to be irrigated adequately by the amounts available.

Further development is dependent chiefly on costly surface storage, artificial replenishment of underground storage, and trans-watershed diversion.

In planning storage, adequate provision should be made for long series of consecutive years with less than normal water yields.

The whole subject is complicated by water-right questions and disputes, intrastate and interstate; by diversity of irrigation laws and institutions; and by Federal interests which in many cases have neither been asserted nor formulated.

SECTION II
XII. RECREATION

Water plays an important role in the general problem of outdoor recreational areas, but this matter in its entirety demands attention from a number of functional agencies. The intricate and interlocking problems of land utilization, forestry, conservation of game, location with reference to population centers, and the availability of transportation facilities are questions beyond the defined investigational scope of the Water Resources Section.

However, every river, lake, and bit of coastline has certain potentialities for recreation, and every storage reservoir is a possible center where population may gather for swimming, fishing, and camping. Insofar as problems of stream pollution, drainage, erosion, and the like affect existing or potential recreation facilities, and insofar as existing or potential storage reservoirs may be utilized, in part, to fill needs for play areas in regions where there is a deficiency of natural water bodies, consideration of recreation needs is definitely within the scope of water resources planning.

While the importance of providing adequate recreation facilities cannot be evaluated in dollars and cents, it should be borne in mind that in many areas the resort business and related activities offer major sources of income to resident populations. In the New England States and in the industrial State of Michigan this business is exceeded only by manufacturing as a source of State income; in Michigan its total exceeds $500,000,000 per year, of which $274,000,000 is derived from outside the State.

A form of effective recreational use of water not yet adequately practiced is the construction of small ponds in rural and other areas lacking large bodies of water available for recreational purposes. Construction of such ponds may serve as effective means of unemployment relief, and will provide for fishing, bathing, and local park and recreational areas in parts of the country badly needing such facilities. They may also be so planned as to operate in the aggregate as real water and soil conservation measures.

Systematic planning for the development of recreational opportunities should be predicated upon careful surveys of existing facilities with a view to determining their water problems, and to giving special attention to regions where a paucity of recreation facilities exists.

An inventory of such facilities, made by the Water Resources Section, may be summarized briefly as follows:

The notable summer-resort areas of the coasts and the Great Lakes region, and the winter-resort regions of Florida, Southern California, and the Gulf Coast, are national assets to whose enjoyment the waters add largely. These, and the great national parks and monuments, require more than average means and leisure for their enjoyment by other than nearby populations.

In the north Atlantic drainage area recreational use of the waters is of long standing and growing development, and the maintenance of values predicated on such use is a matter of intelligent public concern. Pollution destructive to fish life is being brought under control; and the maintenance of wild-fowl hunting areas, where encroachment of towns does not prohibit, is a recognized part of public policy. Developed values are high along the beaches; the New Jersey Department of Navigation and Commerce has found the taxable value of the half-mile-wide strip along the coast to exceed that of all agricultural lands within the State. Under these conditions, coastal erosion is a major problem; works of varying effect in control of it have been extensively built, and more and better protection is needed.

In the south Atlantic and eastern Gulf drainage areas, the southern Appalachian Mountain resorts are widely popular; they contain no natural lakes, but artificial lakes under restricted recreational use are increasing in number. Sport fishing in the mountain streams is being improved by stocking in some areas. Recreational waters in the Piedmont are limited to water-power reservoirs and commercial swimming pools. More available facilities are needed. The coasts provide sea-bathing resorts in every State, with several famous sport-fishing and wild-fowl hunting areas; and larger wild-game hunting in many coastal swamp regions. Coastal erosion is active on the Atlantic beaches, with insufficient control. Provision for public recreational use of waters is relatively not well established in public policy in this region.

In the Mississippi Basin, the areas near the headwaters are found to be well supplied with recreational facilities. In the mountainous western part of the basin, national forests and national parks cover large areas. Throughout Wisconsin, Illinois, Indiana, and Ohio, there is hardly a spot that is more than 75 miles from some area of the "State park" type, or some public forest. In Tennessee, however, there seems to be a shortage of recognized recreational areas, while in the Great Plains, the Dakotas, Nebraska, and Kansas a serious lack of them makes the existing or potential recreational value of water-storage projects especially important. South of the Ozarks, principally in

Arkansas, are areas considered particularly desirable for recreational development. The Lake of the Ozarks, a large artificial water-power reservoir, is a good example of provision for recreational uses.

The Great Lakes and Red River drainage basins are notably adapted by nature for public enjoyment of their waters, more particularly in the northern and western areas, and public policy is intelligent in its encouragement. Indiana is providing a large lake-front State park; Ohio is least well provided. In New York the lake resorts have long been famous; many are under private control. Beach erosion is a problem, but not yet of major proportions.

The northwest Pacific drainage is abundantly favored with great recreational areas, containing more than one-third of all national forests and five great national parks. More than 500,000 visitors annually use these parks. The States of Washington and Oregon have provided along their coasts and along the principal rivers a number of small State parks, camp grounds, and scenic points reserving to public enjoyment spots of particular scenic interest. Coastal erosion from the public standpoint is relatively unimportant.

In the southwest Pacific and Great Basin, the long dry summers and mild winters have served to develop in California world-famous recreational areas, and a vast annual revenue from tourists. In all instances the streams, lakes, and beaches are a major attraction. In the arid interior, in the Great Basin, the Great Salt Lake of Utah is notable, and some of the desert springs have developed winter resorts. Public policy is actively concerned in developing public recreational use of the waters.

In the Colorado River Basin, recreational water uses are available only in the headwater areas; the Boulder Dam and other large reservoirs lower down the Colorado will extend them into the heart of the Nation's most ari region.

In the southwest and western Gulf drainage, pa ticularly in the more arid uplands, there is increasin popularity of bodies of surface water for recreationa use. Growing public confidence in modern filtration o water supplies is extending the use of larger water suppl reservoirs for boating, fishing, and wild-fowl hunting On the coast, most towns from Galveston south hav bathing beaches and generally good fishing and hunt ing. Sea-wall protection from tropical hurricanes i essential to Gulf coast communities, but as storm wave protection rather than erosion control.

The regional reports suggest the following summari zation of the aspects from which recreational uses should be considered in national water-use policy:

1. Protection of cleanliness and of fish life by contro of pollution.

2. Protection of wild-fowl hunting areas, by restraint of ill-advised drainage.

3. Retention of rights to reasonably regulated public recreational use in connection with future storage reservoirs.

4. The provision of ponds in rural and other areas lacking large bodies of water suitable for recreational purposes.

5. Encouragement of proper water-supply filtration as a means of extending recreational use of public water-supply reservoirs.

6. Maintenance of present liberal policies, and particularly of personnel qualified by high character and training, in field control of the public use of national recreational areas, as is now notably successful in National Forest and Park Services.

7. Prosecution of Federal studies and advisory service for the economic control of coastal erosion.

SECTION II

XIII. HYDROELECTRIC POWER

By Willard E. Herring

I. Basic Determinants of Water Power

Water power is a function of the amount of stream flow and the hydraulic head available. These basic determinants of water power, broadly interpreted, are but the amount of precipitation—whether as rain or snow—and the variations of topographic relief. With the widely differing physical and climatic conditions in the United States, extreme variations in water power for different parts of the country are to be expected. By comparing a topographic map of the country with a rainfall and drainage map, one's attention is quickly attracted to regions in which power sites should be relatively numerous and to regions of relative scarcity. The Pacific Northwest, with its mountain ranges and heavy precipitation, stands in marked contrast to the great central plains where the rainfall is light and the country flat. Even in areas of more comparable precipitation, the inherent water power varies because of differences in stream gradient, such as between the lower Mississippi and the international section of the St. Lawrence. It is to be expected, therefore, that the installed and potential hydro power will show variation among regions in accordance with the inherent physical determinants.

II. Developed Hydro Capacities

According to the most recent census reports available, the total capacity of prime movers installed in the United States was 54,296,800 kw. This installation was distributed among the principal classifications as follows:

	Total kw	Water-power kw	Fuel-burning kw
Central stations	35,975,200	10,149,000	25,826,200
Electric railways	1,147,800	22,500	1,125,300
Manufacturing [1]	15,116,500	1,169,700	13,946,800
Mines and quarries	2,057,300	34,600	2,022,700
	54,296,800	11,375,800	42,921,000

[1] It is significant that from 1919 to 1929 the total capacity of prime movers in manufacturing remained practically constant at 15,000,000 kw, while electric motors driven by purchased energy in manufacturing plants increased from 21,896,000 kw to 32,198,000 kw, an increase of 47 percent.

Whereas in 1921, the capacity of water wheels installed in all water-power plants was 5,945,469 kw, in 1931 the capacity was 11,163,500 kw—an increase of 88 percent. On January 1, 1934, the total capacity of water wheels in water-power plants of 75 kw and over was 11,935,000 kw. The installed capacity of generators in hydro plants producing electricity for public use (as distinguished from prime mover capacity) on January 1, 1934 was, according to the United States Geological Survey, 9,773,302 kw. This hydro figure represents 27 percent of the total of such central station capacity, as is shown by regions in the following table:

Region	Total capacity, kw.	Fuel-burning, kw.	Water-power, kw.	Water-power percent of total
North Pacific	1,380,732	351,957	1,028,775	74.5
South Pacific	3,162,266	1,214,265	1,948,001	61.6
Colorado	198,503	78,749	119,754	60.3
West Gulf	961,458	936,808	24,650	2.6
Southwest Mississippi	885,186	788,686	96,500	10.9
Missouri River	1,749,510	1,300,560	448,950	25.7
Upper Mississippi	2,264,035	1,792,319	471,716	20.8
Alluvial Mississippi	356,109	356,109	0	0.0
Ohio River	4,650,694	3,835,391	815,303	17.5
Great Lakes	6,217,198	5,054,069	1,163,129	18.7
North Atlantic	10,606,778	8,779,854	1,826,924	17.2
South Atlantic	3,605,996	1,776,396	1,829,600	50.7
	36,038,465	26,265,163	9,773,302	27.1

This development of hydro power has not proceeded solely on the basis of the availability of power sites, but has been modified and conditioned by the organic growth of the national economy, of which power is but one factor. The density and movement of population, the location of different types of industrial activity, the distribution of resources, and the varying rates of technological development, are but a few of the elements entering into this interplay of relationships. It is factors such as these which ultimately determine utilization of power sites. However, the number of power sites in the Nation is not infinite; an absolute limit is imposed by the physical characteristics. Of this limited number of sites, only a lesser number is feasible for development at any particular time, depending upon the stage of arts and technics. The remaining undeveloped sites and their capacities warrant careful study, for they constitute a limited natural resource.

III. Undeveloped Hydro Capacities

While the United States has a vast quantity of undeveloped water power, which is now or potentially

feasible of development, no very detailed estimate has ever been made.[1] As no information is available of the potential power at developed sites, it is impossible to derive a figure representing the total amount of undeveloped power. Therefore, in attempting to reach a figure which would approximate the undeveloped water power in the country, it has been decided to limit the figure to feasible undeveloped sites. As estimated costs were available for many projects, it has been possible to eliminate potential sites whose costs, in the light of present costs for competitive power, were unreasonably high.

The time allowed for this study has been insufficient to collect and analyze thoroughly and in detail all the existing information. The sources from which data were obtained include the "308" reports of the Corps of Engineers, the Federal Power Commission, the Geological Survey, and of water resources, conservation, and State engineer reports of several States. In addition, information has been supplied by the regional water consultants of the water-planning committee, other engineers and technical workers, and private interests.

It is realized that the figures here may vary from the "true" figures because of (1) inadequate stream flow records, (2) fragmentary information regarding proposed dam sites, (3) possible omission of some sites, (4) inaccurate cost estimates, and (5) insufficient data relative to storage possibilities It was hoped that there would be adequate data to show the 90-percent and the 100-percent time-flow power for the country, but on the tributary streams of the Sacramento and San Joaquin Rivers in California with millions of kilowatts of undeveloped power, on the Umpqua, Rogue, and Deschutes Rivers in Oregon with potential power of a million kilowatts, and on the Upper Snake River in Idaho with nearly two million kilowatts of undeveloped power, no information was available other than rough preliminary estimates. The Corps of Engineers has not yet reported on these rivers. Neither has the State of California in its studies of its water resources completed the surveys on the above-mentioned streams in California.

The table at the foot of the page shows, by regions the undeveloped water power in the United States—projects of less than 1,000 kw excluded. The prime power, i. e., 97 to 100 percent time-flow power, currently feasible of development, with regulated flow at a majority of the sites and with an average over-all efficiency of 75 percent, is 21,311,700 kw.

For all regions except the North Pacific and the Colorado River, the ratio of the proposed installation capacity to 100-percent regulated time-flow power is 2.53. If this same ratio is applied to the total feasible power of 21,311,700 kw, it indicates an installation of 55,000,000 kw, or about 5 times the present installed capacity of water wheels in all water power plants.

As the summary table shows, the undeveloped feasible power varies greatly among drainage regions. Each of these regions will be discussed briefly and some of their outstanding power characteristics presented.

North Pacific: Between the Continental Divide, which forms the eastern boundary of this region, and the Pacific Ocean lie the Rocky, Bitter Root, Cascades, Coast, and Olympic Mountain Ranges. While the moun-

[1] About 25 years ago the United States Geological Survey made an estimate of total water power, which has been revised from time to time. This estimate, as of Feb. 11, 1928, showed the 24-hour power available 90 percent of the time with an over-all efficiency of 70 percent to be 28,583,000 kw. But this figure includes both developed and undeveloped sites.

Summary of feasible undeveloped power by regions

Region	Regulated 90 percent T.F.[1], kw	Regulated 97 to 100 percent T.F kw	Feasible installation, kw[2]	Primary energy, 1,000 kw-h	Cost, dollars per kw installed	Costs at plant	
						Mills per kw-h primary energy	Mills per kw-h total energy
North Pacific	10,348,200	8,565,200			[4] 63 to 115	[4] 0.86 to 1.72	[4] 0.80 to 1.66.
South Pacific		[3] 3,554,000	6,873,500				
Colorado		2,400,000					
West Gulf		67,500	355,500				
Southwest Mississippi	208,800	186,400	484,300	1,632,700	165 to 269	3.74 to 5.26	2.70 to 370.
Missouri River		640,800	1,749,500	5,618,900	240 upward	5.09 to 9.95	
Upper Mississippi		50,300	313,300	439,800	156 upward		
Alluvial Mississippi		0	0	0			
Ohio River		3,443,500	8,753,600		118 to 274	4.29 to 9.74	
Great Lakes		1,008,700	1,477,800	8,796,000	109 to 267	[5] 1.21 to 9.30	[5] 1 07 to 5.90.
North Atlantic		474,900	2,864,800		136 to 216	4.00 to 12.90	3.70 to 5.90.
South Atlantic		920,400	3,311,300	8,062,600	129 to 242	5.10 to 8.35	3.30 to 7.33.
Grand total		21,311,700					

[1] T.F.=Time flow.

[2] Proposed installation not available for all projects but at 9 projects on the main stem of the Columbia River with 3,691,000 kw of prime power an installation of 7,306,000 kw is feasible.

[3] Estimate based on average flow.

[4] 9 plants on main stem Columbia River only.

[5] Minimum cost is at St. Lawrence River project.

NOTE.—Unit costs are shown for only those regions in which the projects have been investigated and cost estimates prepared.

tains trend in a north and south direction, the prevailing winds are from the west and southwest, so the moisture-laden air from the Pacific releases its precipitation as it travels eastward. As shown on the rainfall maps on page 292, the highest precipitation (over 150 inches annually) is found in the Olympic Range, then decreasing to about 40 inches in the Puget Sound area, again increasing in the Cascades to about 115 inches, dropping off rapidly in the Columbia River Valley to about 10 inches and again rising to around 40 inches in the Rocky Mountains.

The principal stream in the region is, of course, the Columbia River. At the point where it enters the United States, the Columbia has, from a drainage area of about 39,000 square miles, a minimum monthly flow of 10,000 second-feet, a minimum mean annual discharge of 55,200 second-feet, and an average annual discharge of 71,400 second-feet. The Columbia River with its tributaries accounts for 7,554,800 kw of the 8,565,200 kw of 100 percent time flow power of the entire region. The main stem of the river from the Bonneville plant to Grand Coulee can contribute 3,691,000 kw, the Snake River 2,163,000 kw, and the Willamette 426,000 kw. For the main stem and the Willamette, the proposed installations are 7,306,000 kw and 753,000 kw, respectively. The primary energy available from the projects on the main stem is estimated to be over 32 billion kw.-hrs., with costs at the switchboards of the plants varying from slightly under 1 mill to less than 2 mills per kw.-hr. of primary energy. The power project costs vary from $70 to $115 per kw of installation.

There are but three other rivers of major importance from a power standpoint in the region. They are the Skagit in northern Washington and the Umpqua and the Rogue in southern Oregon, with an estimated total prime power of 688,000 kw. The Skagit River is now being developed by the city of Seattle; one plant is operating and one under construction.

South Pacific: The most important topographical feature in this region is the Sierra Nevada Mountain Range and of secondary importance is the Coast Range. The high Sierras have a distinct influence on the climatic conditions, separating the State into two distinctly different areas climatologically. The moisture-laden clouds from the Pacific deposit part of their burdens in the Coast Range, less in the central valley, and practically all of the balance in the Sierras.

With this relatively heavy precipitation, and with the sharp fall in the Sierra streams flowing to the westward, many opportunities for power development are found on these tributary streams of the Sacramento and San Joaquin Rivers. As stated, little information is available concerning the power potentialities of these rivers, although it is probable that private interests have investigated all the tributaries. Plans of the State of California include the Kennett Reservoir in the upper Sacramento, where 113,000 kw of prime power (installation proposed 300,000 kw) could be obtained if the flow were regulated for power only. Practically all power available is on the western slope of the Sierras, since to the east the deficiency in precipitation precludes developments.

The other two important power rivers of the region are the Klamath and the Eel. The former rises in southeastern Oregon and is estimated to be capable of producing 490,000 kw of prime power while the latter, although it has a large amount of potential power, is capable of producing economically only 52,800 kw of prime power.

Colorado River: The outstanding feature of this basin is, of course, the canyon of the Colorado River. Besides that especially notable development, Boulder Dam, there are three sites on the river above Boulder Dam which have about the same power possibilities as exist at Boulder. A smaller potential development, though perhaps better known, is the Flaming Gorge site on the Green River in Colorado.

Because of the fact that water in this area has a preferential use for irrigation, it is estimated that water available for power will decrease as irrigation demands increase. Although the present water supply indicates a possible development of 4,000,000 kw, the amount shown in the table as feasible of future development is lower because of this irrigation preferential.

Western Gulf: This region comprises the Rio Grande and those streams which flow into the Gulf of Mexico between the Rio Grande and the Mississippi Drainage Basin. These rivers pass through the arid lands of New Mexico and Texas, and consequently, at certain periods of the year, become practically dry and devoid of primary power. Although some power production is feasible, the use of water for irrigation is of much greater importance.

Southwest Mississippi: Slight precipitation and runoff in a comparatively flat region are the factors which account for the small contribution of this region—approximately 1 percent—to the total undeveloped power of the country.

Missouri River: The paucity of precipitation over the western portion of this region, and the resultant light stream flow, are compensated by the high heads which the steep gradient streams permit for water-power developments. The majority of the proposed power sites are found on the streams tributary to the Missouri River, for as the Missouri enters the Great Plains, its power potentialities disappear. The Yellowstone River accounts for 42 percent of the power deemed feasible of development. On the Platte River, irrigation is the principal use for water, and water-power developments are found in conjunction with and subordinate to irrigation dams and

diversions. Despite its position as first in area among the regional districts, the Missouri Basin contributes only 3 percent to the total feasible undeveloped power in the United States.

Upper Mississippi: Physiographically located entirely within the central lowland, this region contributes only one-quarter of 1 percent to the total undeveloped water power of the United States. Though abundant flow is available in many of the rivers, few natural falls or dam sites are suitable for development. Primary power costs in this area are relatively high, but considerable moderate-cost secondary energy would be available. The preponderance of steam installation in the region would allow the absorption of much of this secondary energy.

Alluvial Mississippi: Though an immense volume of water flows down the wide valley of the lower Mississippi River, the absence of both dam sites and appreciable natural head precludes water-power development.

Ohio River: In undeveloped primary water power this region ranks third in the entire country, but is first among the nine regions east of the Continental Divide. Almost all of the available power is to be found in the southern and eastern portion of the region. The Tennessee River and its tributaries account for nearly 70 percent of the total primary power, while the Kanawha, Cumberland, and Cheat Rivers make large contributions. Precipitation over the basin averages over 40 inches per year with a considerable portion receiving more than 50 inches. Head is provided by the western slope of the Appalachians.

Though the power sites lie in rugged, mountainous territory into which no intensive industrialization has penetrated, important manufacturing centers are within economical transmission range. Furthermore, the developments are of such size and so favored by the natural features that energy costs would be relatively low.

Great Lakes and St. Lawrence: The Great Lakes basin, with its vast surface and ground water reservoirs, has great power potentialities which topographical peculiarities have concentrated in two principal areas.

By existing international agreement the diversion from the Niagara River for power purposes is limited at present to 20,000 cubic feet per second for the United States. No development has yet been made on the American side to utilize the treaty allotment of water in the Gorge Rapids section below Niagara Falls.

The International Rapids section of the St. Lawrence River affords an opportunity for the largest single development of primary power in the United States—over one-half million kilowatts of primary power would be available. The proposed installed capacity is 825,000 kw. According to the New York Power Authority, energy could be produced at an extremely low cost, so low, in fact, that the part allocated to this service could be transmitted a distance of 300 miles to New York City and sold in competition with that from the existing sources of supply.

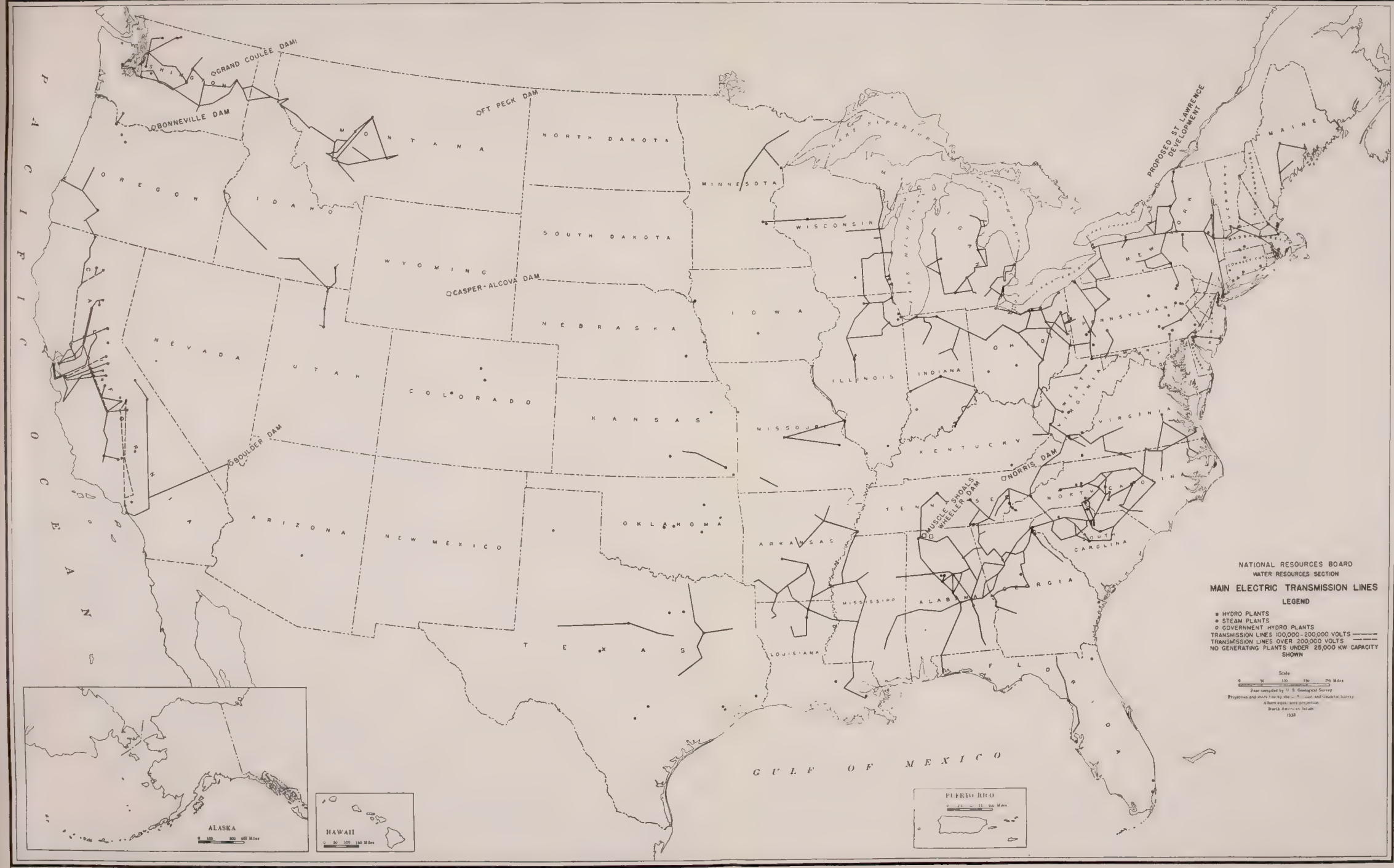
Numerous scattered small developments, generally with less than 10,000 kw of proposed installation, are located on the streams of the Superior upland that empty into Lake Superior and northern Lake Michigan.

North Atlantic: In New England water power has had a distinct influence on the location of industries and distribution of population. Although power sites are relatively small and scattered, the industrial development of this area for the first half of the nineteenth century was intimately linked with the selection of mill and factory sites at which stream flow could be utilized for power. The advent of electrical transmission of power together with the improvement of hydro-plant design has brought a more complete utilization of the power in these New England streams. Today but a small part of the feasible water power in this region remains undeveloped. For example, it is estimated that the Deerfield River in Massachusetts and the Blackstone River in Connecticut are completely developed by the series of power installations along their course.

The Delaware and Susquehanna Rivers provide the most important sources of potential water power in the region. It is planned to use the abundant flow of these rivers at medium head sites, and, in some cases, by multiple-purpose dams.

Eastern Gulf and South Atlantic: The power sites in this region lie, for the most part, inland from the fall line. Streams rising in the Piedmont section and in the mountains immediately to the west and north receive the run-off from a precipitation which ranges from 50 to over 80 inches annually. Although some sites have been developed—the Catawba River in North Carolina and South Carolina represents an outstanding example of virtually complete development—the descent of these waters to the Coastal Plain furnishes generous possibilities for power development at moderate costs. The Potomac, Santee, and Chattahoochee Rivers have the greatest undeveloped power possibilities in the region. Together they offer 500,000 kw.

These sketches of regional potentialities have been confined to undeveloped water power and are exclusive of the benefits to be derived other than for power purposes. The development of water power in many cases is closely allied with flood control, low-water control, irrigation, and navigation. Any dam constructed to impound water for regulating stream flow for power purposes would probably hold back some of the flood waters, and the regulation of flow would, in most cases, result in an increase of the low-water flow, thereby


GRAND COULEE DAM
BONNEVILLE DAM
FT PECK DAM
CASPER-ALCOVA DAM
BOULDER DAM
NORRIS DAM
MUSCLE SHOALS
WHEELER DAM
PROPOSED ST. LAWRENCE DEVELOPMENT
WASHINGTON
OREGON
IDAHO
MONTANA
NORTH DAKOTA
MINNESOTA
WYOMING
SOUTH DAKOTA
NEBRASKA
IOWA
NEVADA
UTAH
COLORADO
KANSAS
MISSOURI
ILLINOIS
INDIANA
OHIO
KENTUCKY
WISCONSIN
MICHIGAN
NEW YORK
PENNSYLVANIA
WEST VIRGINIA
VIRGINIA
MAINE
ARIZONA
NEW MEXICO
OKLAHOMA
ARKANSAS
TEXAS
LOUISIANA
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
SOUTH CAROLINA
NORTH CAROLINA
TENNESSEE
PACIFIC OCEAN
GULF OF MEXICO
ALASKA
HAWAII
PUERTO RICO
NATIONAL RESOURCES BOARD
WATER RESOURCES SECTION
MAIN ELECTRIC TRANSMISSION LINES
LEGEND
HYDRO PLANTS
STEAM PLANTS
GOVERNMENT HYDRO PLANTS
TRANSMISSION LINES 100,000-200,000 VOLTS
TRANSMISSION LINES OVER 200,000 VOLTS
NO GENERATING PLANTS UNDER 25,000 KW. CAPACITY SHOWN
Scale
Base compiled by U. S. Geological Survey
Projection and chart line by the U. S. Coast and Geodetic Survey
Albers equal area projection
North American datum
1933

favorably affecting water supply, sanitation, and navigation.

Also no attempt has been made to consider the "firming up" possibilities among the resources considered—the use of storage reservoirs as sources of additional power which may through interconnections be drawn upon when and where needed to meet peak loads most economically. Any water power development is more valuable if storage is available to supplement the natural flow of the stream.

Furthermore, this discussion has been concerned with the existence and the probable capacities of feasible undeveloped power sites, and not the advisability of immediately developing any particular sites. Hydro plants now represent about 27 percent of the total installation in central station plants, as compared with 22 percent in 1922 and 29 percent in 1917. In 1933 they produced 40.7 percent of all energy generated as compared with 36.5 percent and 39.5 percent in 1929 and 1928 respectively. Increased efficiencies in steam plants are partly responsible for this rather constant ratio, and, other factors considered, it does not seem probable that there will be any material increase in the ratio in the immediate future. After the more desirable hydro sites have been developed of course the ratio will tend to decrease.

Each proposed project has its own special problems, but among the factors governing the most desirable ratio of steam to hydro capacity are (1) the shape and size of the load curve, (2) prime capacity of hydro stations, (3) "peaking" possibilities of the hydro plant, (4) the relative cost of steam and hydro plants, (5) the energy cost at the point of use, and (6) the degree of interconnection between steam and hydro.

IV. Transmission Lines

With but few exceptions, the undeveloped water-power projects are remote from industrial centers, and hence require relatively long transmission lines to conduct the energy to the point of use. In the earlier days of the electrical industry each area was dependent upon the plants in that area for its electric power supply. In later years, however, and especially with the advent of the holding company, interconnection by means of high-voltage lines has progressed, primarily for the economies effected through increased use of existing generating facilities, the deferring of new generating plant construction, and the interchange of power among water-power plants where low water conditions were not coincident in time. That these advantages arising from the interconnection of plants and systems have been recognized by many of the utility companies is shown by the accompanying transmission line map. Particularly noteworthy are the networks in the Southeast—in northern Indiana, Ohio, West Virginia, and western Pennsylvania—in California, and the 220,000-volt lines in eastern Pennsylvania and New Jersey.

The circuit mileage of transmission lines, December 31, 1932, operating at 66,000 volts or over, was as follows:

Total mileage

	Data from United States Census Electrical Industries, 1932				Data from Edison Electric Institute, 1932
	Underground	Pole line	Steel tower	Total	
66,000 volts	166	20,775	8,767	29,708	28,623
88,000 volts				859	
110,000 volts		6,893	10,186	17,079	15,280
132,000 volts	36	1,679	6,539	8,254	7,918
154,000 volts				429	
220,000 volts			1,903	1,903	1,948
Total				58,232	53,769

V. The "Grid" System

The British "Grid" is a system of interconnected transmission lines operated by the Central Electricity Board, and so planned that practically all of the generating and distributing interests in the country can effect a connection. This transmission network is the primary transportation system for electrical energy, and it may be termed a "common bus bar" into which the generating plants of least cost feed their energy. Whatever the load conditions may be at any particular time, the energy that is distributed is being generated at the lowest net cost. The objectives are to provide all sections of the country with as much present and future power as they respectively require, and to make it all available at the lowest cost.

More specifically, among the advantages of such an interconnected or grid system are:

1. The amount of necessary reserve capacity is reduced, and therefore idle investment and costs are reduced. Individual plants, when unrelated as in the past, were each built with excess capacity to take care of future growth of demand. The aggregate of such excess capacities of unrelated plants is always greater than the necessary excess capacity for the same group of plants when interconnected.

2. The power available from reservoirs can be drawn upon to firm up the power to meet peak load demands most economically when and where required throughout the system.

3. Through the interconnections each community is provided with more than one source of supply, so that continuity of service is more nearly assured.

4. By increasing the area of an integrated power consuming market larger and more efficient generating plants may be constructed.

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Also no attempt has been made to consider the "firming up" possibilities among the resources considered—the use of storage reservoirs as sources of additional power which may through interconnections be drawn upon when and where needed to meet peak loads most economically. Any water power development is more valuable if storage is available to supplement the natural flow of the stream.

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2. The power available from reservoirs can be drawn upon to firm up the power to meet peak load demands most economically when and where required throughout the system.

3. Through the interconnections each community is provided with more than one source of supply, so that continuity of service is more nearly assured.

4. By increasing the area of an integrated power consuming market larger and more efficient generating plants may be constructed.

5. By means of interconnecting lines, daily and seasonal load factors may be improved.

The largest saving arising from a grid is the reduction of excess generating capacity in the interconnected area. In an area extending from Keokuk and St. Louis to Detroit, including Chicago and Milwaukee, the installed generating capacity is 4,585,000 kw, of which only 66 percent was in use as measured by the maximum peak load. Using 15 percent as an estimate of the excess capacity necessary to sound operation, there would remain 1,105,000 kw of installed equipment not in use in this area if all generating plants were feeding into a comprehensive system. At a cost of $100 per kw this would represent in this area alone an investment of over $110,000,000 on which the utility companies would expect to base their earnings, and which would not be required if the proper interconnections among companies were in effect. The present rate of growth of interconnection is too slow to meet the public need; the Government should exercise its powers of leadership, as it did during the World War, if we are to increase our consumption of electricity through the lowering of rates. Great Britain has recognized this fact and has met the demand by establishing the grid system.

VI. Rural Electrification

One of the most important industries in the country is and will continue to be agriculture. Its proper development is highly essential to the Nation. A farm is really a factory whose output is produced through the application of labor and power to natural resources. Of the 6,200,000 farms in the United States, only 850,000, or 13 percent, have electricity. If so-called "farms" in the suburban areas of cities are excluded, the percentage would probably drop from 13 to 10 or less. It is estimated that about 12 billion kw.-hr. of energy are utilized on farms annually, of which about 1 billion kw.-hr, are now supplied by electricity. If 60 percent of the cost of production is for power and labor, it can readily be seen that the successful use of cheaper and more efficient power would result in tremendous savings to agriculture. Other industries have recognized the uses to be made of reliable and low-cost power and have almost universally adopted electric power. Agriculture, however, has lagged, due in many cases to its inability to secure service. It therefore seems necessary for the Government to stimulate the extension of this service in many areas. A survey is needed to find those areas that are not supplied with electricity and where the density is not less than three farm houses per mile of proposed line. Then surveys of several such areas should be made in order to determine the line construction work that would be necessary, whether or not the projects would be self-liquidating, and what arrangements for development and service are feasible, either through local companies or otherwise.

SECTION II

XIV. REPORT OF THE PORTS AND PORT TERMINALS COMMITTEE[1]

SUMMATION OF FINDINGS

Investment in Facilities for Waterborne Commerce

Water-borne commerce of the United States has been under subvention by the Federal Government for more than a century, since 1824, when the first appropriation for channel-improvement work is recorded. At the present time, 75 ports of major rank and 260 others of minor but appreciable importance are under improvement by the Government. Outside of these 335 coastal, lake, and river ports, there are hundreds of minor improvements carried on the records of the War Department, aggregating altogether 950 separate undertakings of this general character. Federal expenditures have been devoted to a wide variety of improvements, including the dredging of channels and anchorages, the construction of breakwaters, harbors of refuge, dikes, revetments and other channel-training and protection works.

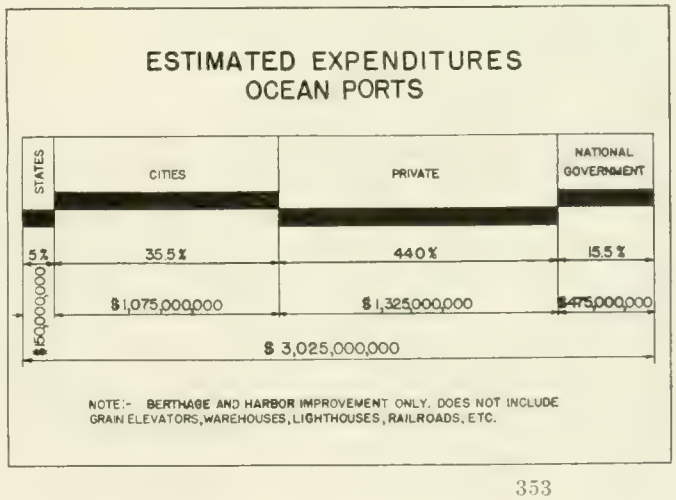
Since the original modest appropriation a century ago, governmental encouragement of maritime commerce has expanded to huge proportions. The total amount of money expended by the Federal Government has been approximately $600,000,000 for ports and harbors, $500,000,000 for inland waterways and general water facilities in aid of commerce and navigation—a total of $1,100,000,000 of capital investment. If there is added to this initial investment a further sum of $400,000,000 for accumulated maintenance costs, the total expenditure of Government funds within our continental limits is $1,500,000,000.

Supplementing these Federal expenditures, municipal corporations and public port districts have expended approximately $1,000,000,000, and in purely private harbor and wharf facilities it is estimated that a present capital investment of $2,500,000,000 is represented. If one adds to these the cost of auxiliary harbor facilities closely allied with, and necessary for the operation of ships—including railroad-owned marine terminals, harbor belt railways, warehouses; ship yards, marine railways and repair plants; lighthouses, lightships and buoys—and finally, commercial vessels in the marine industry, the total capital represented is estimated to be fully $7,500,000,000. This large figure affords some indication of the importance of the efficient administration of these interests.

Present Port and Harbor Conditions

1. The Adequacy of Facilities: With a few notable exceptions, there is in most ports a notorious lack of proper coordination of the facilities which go to make up the complete working plant. A few of the ports in the country are well organized, but, generally speaking, the proper relationship between the various operating units of the harbors is not achieved. On this account, in some instances, large expenditures by ambitious local bodies have resulted in unbalanced and inefficient port facilities; and in others, overdevelopment far beyond any present or probable future requirements. Ambitious, but misguided port interests have embraked upon improvident port improvement projects, and have expected the Federal Government to provide funds for collateral channel development to keep pace with such unjustifiable plans. On the other hand, many projects were formerly useful but have served their full purpose in the development of the country and are no longer justifiable.

2. Intraharbor Cargo Handling: In many ports, if not most, the intraharbor movement of shipments is



[1] This review is based upon a comprehensive report covering port and waterway problems from a national standpoint prepared by a special committee composed of the following experts: William Joshua Barney, Baxter Lamont Brown, Marcel Garsaud, George P. Nicholson, Louis C. Sabin, John Meigs, chairman. The committee was assisted by a group of specialists under the direction of Douglas L. Cullison as chief statistician. William Siple acted as rate expert to the committee.

hampered and expensive. Cargo is frequently handled by archaic methods, and the liaison between rail and marine carriers is imperfect. In the case of some ports under the control of railroads, there is a denial to the public of unified, interline switching service. Confusion and infirmity of purpose are too evident.

3. Harbor Rates and Charges: The system of harbor charges in most ports is complex and inconsistent. With public, private, and railroad piers, docks, warehouses, and special handling facilities all operating without a standard as to either rates or services, the assessment of charges becomes chaotic. Few ports are operated at a direct profit. Piers and other facilities for the accommodation of vessels are usually furnished at a loss to the owners, with the intent to recoup through other services rendered, or through indirect benefits of some kind. One finds railroads fighting for ships' cargoes by offering free dockage; ships enjoying this gift to the prejudice of competing ships which pay substantially for similar accommodations at other piers. Lighterage service furnished free by the railroads, at high cost to themselves, but necessitated by competitive practice—and in some cases ordered to be so furnished by the Interstate Commerce Commission—further complicates the situation. All this results in an inconsistent and confusing system of tariffs for intraharbor services and involves hidden rebates and other discriminatory charges which are inequitable and unfair.

4. Pollution: The already notoriously insanitary condition of many of our harbors is becoming critically worse. Chemicals and sewage in suspension cause destruction of paint on vessel hulls and discoloration of white-work and polished metal; noxious vapors affect the comfort and health of those employed on and about ships, and along the waterfront generally. Harbor water taken into ships' tanks, and thence into boilers, engines, condensers, etc., causes financial damage and increases the already high operating costs of vessels. The destructive effects of pollution adversely affect the value of waterfront property.

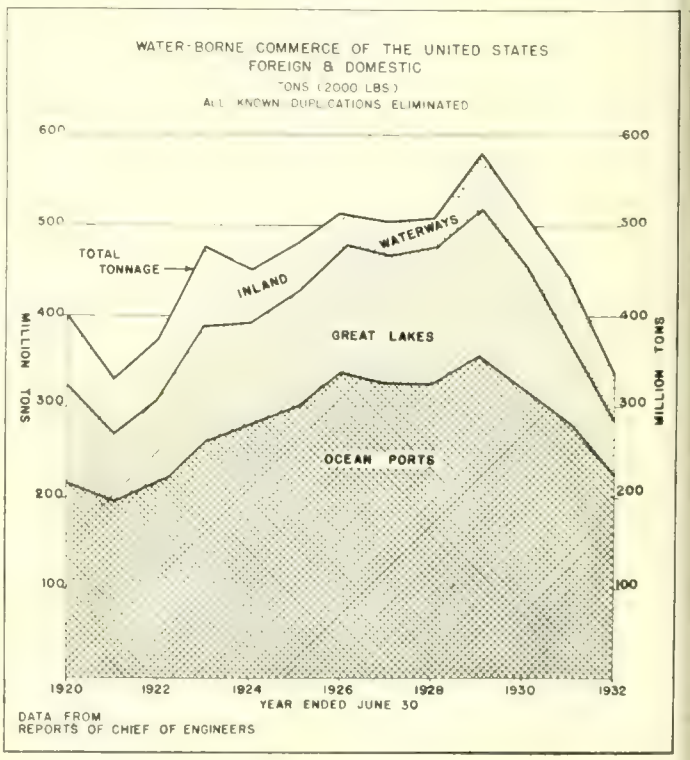
Present Agencies For Port Administration

1. Federal Agencies: The Federal Government, principally through the United States Corps of Engineers and the United States Shipping Board, gathers information concerning the physical aspects of port development and the character and amount of water-borne commerce. Although there is some degree of governmental control and partial supervision over many phases of port and shipping activities, this control is under the direction of 6 different departments and about 20 separate bureaus. In some cases their functions overlap; in others there are unbridged gaps in their jurisdiction. In particular, Federal administration of the planning and construction of commercial port facilities is casual and indirect.

2. Other Agencies: In addition to these Federal bureaus, each having some measure of supervision over a separate and unintegrated portion of the broad problem of supervising maritime commerce, there are legally constituted port commissions, boards, and departments at each of our principal ports, with wide local powers. Each of these port administrations of major rank is hampered in its activities by a swarm of lesser bodies, each having an ill-defined field of its own, and most of them not responsible to any central authority. This multiplicity of ineffective, imperfectly functioning control bodies has resulted in loose, uncoordinated forms of port administration, under which anything approaching a rational policy of development or efficient operation is impossible. Each port considers itself a distinct entity, instead of merely one unit of a national commercial facility; and Government appropriations are sought on the basis of local or sectional influence rather than the broad aspects of the general public good. There is no single agency, local, State, or Federal, comprehending either intraport or interport coordination and charged with any general supervision over the entire situation.

Need for Coordinating Supervision

1. Guiding Principles: The public welfare demands the provision of transportation facilities. More efficient use of the ports and waterways of the country, where



NEW YORK
DELAWARE RIVER
HAMPTON ROADS
NATIONAL RESOURCES BOARD
WATER RESOURCES SECTION
PRINCIPAL WATERWAYS
OF THE
UNITED STATES
SHOWING
SELECTED PORT AND WATERWAY DATA
LEGEND
Less than 9 feet project depth
9 feet project depth
9-15 feet project depth
15-25 feet project depth
25-30 feet project depth
30 feet and over project depth
x x x Private, State, and foreign owned
TYPICAL PORTS AND INLAND WATERWAYS

such use results in lower cost of transport than is possible by other means, must be considered a proper subject of encouragement by the Government. On the other hand, the public interest demands that these facilities, provided at Federal or at local expense, should be so conceived, constructed, and operated as to make a real return to the public. This principle of economic design and operation logically should be applied to all other port facilities as well as to the channels.

2. *Indicated Need for Coordination:* The conclusions relating to existing conditions indicate the necessity for inquiries looking toward the coordination and regulation of all port and harbor facilities. Desirable lines of action suggested by this survey include: The coordination and functional integration of existing and proposed port facilities of every kind, including the harbor belt railroads; the regulation of uniform harbor service charges; the proper balancing of ships and ship accommodations and repair facilities; the correction of harbor pollution; the study and improvement of the charters of incorporated ports; the integration of accessorial service—whether performed by the railroads, ships, pier operators, or private organizations; and the review of all proposed Federal appropriations for works of harbor, canal, and port improvements. Within the area of port operation, specialized independent machinery is needed to effect proper control of such practices without unfair burden on any of the users. In particular, no real reason exists why the marine industry should be subjected to the annoyances of an antiquated and outmoded system of harbor rates and charges. Under a uniform system of rates, applied broadly to all national ports without bias, favor, or subterfuge, the marine industry would be relieved of its present shackles of inadequate standards and wasteful practices.

3. *The Federal Interest:* In view of the unsatisfactory administration of our ports in many particulars and the known existence of many practices inimical to public and business interests, consideration of the principles of genuine economy emphasize the imperative necessity for a coordinating and harmonizing policy. From the standpoint of local and national interest, it seems necessary that the Government should take cognizance of such conditions, and, by the exercise of power already in its hands by reason of its control over the distribution of public funds for channels and harbor improvements, insist upon a rectification of these practices and a compliance with the principles of sound design and economical operation. The financial investment of the United States in these ports should logically vest Federal authority with the responsibility of so administering the facilities which the Government has made possible that they will be economically utilized.

Recommendation

It is believed that while the management of ports as to transfer of goods should remain in local hands, the Federal Government might well participate in the matter of port planning and possibly exercise some appropriate measure of operating supervision and leadership. It is recommended that the entire subject of ports, port terminals, facilities and practices be examined and studied more carefully along broad lines with a probable view to future legislation.

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SECTION II

XV. CONSERVATION OF WATER BY SURFACE AND GROUND STORAGE

Surface Storage

The greater portion of the natural run-off of streams—some 60 to 80 percent of the total annual run-off—occurs during the higher stream stages of late winter and spring. Most of this cannot be concurrently utilized. Therefore holding back a portion of this excess flow by reservoirs, for release during later months of low natural flow, will increase the total usable flow of a stream several hundred percent. Such regulation permits control of water flow for the benefit of domestic and industrial water supply, sanitation, irrigation, power production, navigation, flood control, fisheries, and recreation. For instance, the flow of the Hudson River at Albany has been increased from a natural minimum of about 1,000 c. f. s. to a regulated minimum of 3,000 c. f. s.

In addition to any one of the purposes of stream-flow control enumerated above, reservoirs regulation promotes the coordinated or multiple use of waters. Therefore the utility of water resources as well as the available quantity may be increased by storage. For example, the Hinkley Reservoir built by the State of New York to supply water for the barge canal is also a source of water supply for the city of Utica and vicinity, for power production, sewage purification by dilution, and flood reduction in the Mohawk River. The Exchequer Dam on Merced River, Calif., provides stored water which is released for irrigation, and also creates a large block of hydroelectric power which is used largely for pumping ground water for additional irrigation.

Another important use of reservoirs is to hold and restore to streams water equal in quantity to that taken by diversion for various purposes. Application of this principle permits diversion of the waters of a stream in its upper reaches for some special use without impairing the economic value of the river down stream, and permits diversion from interstate streams or from one basin to another. In this manner by storage and compensation it would be possible for the City of New York to divert a large volume of water for municipal supply from the Delaware River without impairing the value of the river for navigation, power production, and industrial uses down stream.

Sub-Surface Storage

Artesian Ground Water: A large part of the United States is underlaid by artesian reservoirs which under natural conditions contain large volumes of water under pressure. If the pressure is sufficient to deliver water at the surface or within pumping distance therefrom, this is an ideal form of natural conservation by storage. Among its advantages are:

(1) The water is held below a more or less impervious confining and is perfectly protected against loss by evaporation.

(2) Such storage does not require the use by flooding of valuable land.

(3) The storage is often enormously large compared with that available in any ordinary surface reservoir, so that almost perfect regulation is afforded in both wet and dry years.

The greater natural artesian basins include:

(1) The St. Peter Sandstone Basin covering much of Minnesota, Iowa, Illinois, and Missouri;

(2) The Dakota Sandstone Basin in North and South Dakota, Minnesota, and Nebraska;

(3) The Marshall Sandstone Basin of southern Michigan;

(4) The Atlantic Coastal Artesian Basin, particularly from New Jersey to Florida;

(5) The Gulf Coast Basin in Alabama, Louisiana, Mississippi, and particularly in the Carrizo Sandstone in Texas;

(6) The Southern California Artesian Basin;

(7) The Central California Artesian Basin or San Joaquin Basin;

(8) The Roswell Basin in New Mexico, which is probably the most productive single artesian basin.

Ranging downward from these great artesian basins are others of all sizes.

Under natural undisturbed conditions the water stored in these artesian reservoirs remained at nearly constant equilibrium levels—that is, the outflow to the streams and to the sea was equal to the inflow. Excessive draft from some of these basins by wells has greatly depleted the underground reservoirs in some instances, as in southern California, central California, and the Dakota Sandstone basins. The people living on the

overlying lands are largely dependent on the artesian water for their existence.

Hitherto conservation of artesian water has been mainly directed toward prevention of waste. This is important, and much has been accomplished through State legislation and otherwise. Many of the great artesian basins are interstate; and broader, more specific, and more general measures for restriction of waste are needed.

In order to keep underground reservoirs filled, attention must be given to the inflow as well as the outflow. The permanent yield of an artesian basin can be no greater than the inflow to the soil and rock over its intake area. In most cases the intake areas are more or less concealed under overlying deposits and their outlines and extent are not fully known. Conservation of artesian water resources requires an early determination and mapping of the location and extent of important artesian intake areas and the study of their hydrology.

Some of these artesian storage reservoirs contain the equivalent of many years of rainfall on their intake areas. The supply, when exhausted below pumping level, may require many years for its restoration to its original natural level. Artificial replenishment by water spreading and other means may be desirable, also the stimulation of natural replenishment by reducing run-off and waste by evaporation, and by maintaining the soil in a condition of maximum absorptive capacity.

Where the land is not highly developed and definite accomplishment along these lines is possible, it may be desirable to set aside the whole or a part of the intake areas of some of the great artesian basins as natural water reserves.

Ordinary Ground Water: In addition to the great artesian basins, there is throughout a large part of the United States a superficial groundwater reservoir which usually contains water within easy reach by shallow wells. Almost everywhere east of the one hundredth Greenwich meridian it contains a water supply which is permanent except in very dry years, and adequate for rural domestic and stock-watering purposes. Locally the supply may be much greater, particularly in the deep glacial deposits overlying much of the Central Plains and the lower lake region, where surface groundwater supplies adequate for farm irrigation and municipal use are of common occurrence.

The enormous extent of this groundwater reservoir may be realized from the fact that except for regulation by natural lakes it supplies the dependable or perennial flow of all streams. Without it nearly all rivers and streams would go dry at times.

The superficial groundwater reservoir is replenished from that part of the rain which enters the overlying soil as infiltration. Methods of cultivation and use of land which tend to pack the soil or reduce its capacity to absorb rain may result in serious lowering of the groundwater and reduction in the groundwater reservoirs. Lowering of groundwater levels in the superficial groundwater zone has undoubtedly taken place more or less extensively. It appears certain that this lowering has in general been more commonly the result of periods of low rainfall, of overintensive agriculture, and improper methods of cultivation and use of land, rather than because of overdraft of water from wells.

Restoration of groundwater levels and conservation of the groundwater resources in the superficial zone can be brought about only through methods of cultivation and use of land which permit the normal amount of water to enter the soil as infiltration and which prevent soil moisture being withdrawn in excess by crops or otherwise.

In relation to natural underground storage reservoirs, general legislation is needed (a) to prevent waste and (b) to restrict use of an amount not exceeding available supply. In some cases more drastic restrictions are needed for a period of time to restore groundwater levels and storage to natural conditions; e. g. (c) to set apart suitable intake areas of larger artesian basins or portions thereof as water reservations and to provide for increase by suitable means of inflow to the artesian aquifers.

Existing and Potential Storage

The following is a summary of storage conditions in various regions of the United States:

Western Mountain and Plains Regions: In this region the larger valleys and plains are relatively arid, but rainfall is generally more plentiful in the mountains. Winter snow accumulation is chiefly relied upon for summer water supply. Snow storage surveys are made to a certain extent for the purpose of predicting the available supply for the following summer season. Generally speaking, stream regulation is carried out for the primary purpose of irrigation, but invariably accomplishes coordinated services such as flood control and often extensive power production.

One of the major problems with reference to stream regulation by storage in this, as also in the southern regions, is that of the filling of reservoirs by silt. No complete solution of this problem has been found. The best existing solution is by the reservoirs themselves; which means, of course, that in some instances more reservoirs and larger reservoir capacities must be provided than would otherwise be necessary to maintain a given ultimate degree of regulation.

Filling of reservoirs by silt has been referred to in the section on Surface Waters and Flood Control. It constitutes a large economic waste which may be alleviated by erosion-control measures and improved agricultural practices.

North Pacific Drainage: This district comprises Washington, Oregon, and Idaho, where there are at the present time over 300 major reservoirs, constructed primarily for power development, having an aggregate capacity exceeding 45 million acre-feet. There are in addition in this region about 30 major-storage projects, undeveloped or partially developed, exceeding 50,000 kilowatts capacity each, in conjunction with which the development of about 200,000,000 acre-feet additional storage capacity is proposed.

South Pacific Drainage: Comprising chiefly California and the Great Basin in Nevada and Utah. Here water is abundant in certain mountain streams and at present storage and diversion are more highly developed than in any other section of the United States. This has resulted in part because land value is predicated almost wholly on water available for use thereon. Existing storage reservoirs in this district, primarily for power, have a capacity of 14,700,000 acre-feet, and about 5,000,000 acre-feet additional capacity are available and have been carefully studied with reference to future development. Existing surface storage reservoirs, primarily for irrigation, have a capacity of over 7,250,000 acre-feet, part of this being used for public water supply mainly in the cities of San Francisco and Los Angeles.

Colorado River Basin: There are already developed in this region some 50 major reservoirs for irrigation with capacities ranging from 1,000 up to 278,000 acre-feet and comprising a total of over one-half billion acre-feet. There are about 100 proposed reservoirs for irrigation, ranging in capacity up to 90 million acre-feet, 20 of these being of over 100,000 acre-feet capacity each. The Boulder Dam project now under construction will provide 30.5 billion acre-feet of storage.

Western Gulf Drainage: Existing storage development in 33 major reservoirs comprises an aggregate capacity of around 500,000 acre-feet. Primary use of the reservoirs is divided between power production, irrigation, and water supply, with some instances of reservoirs constructed primarily for flood control.

Mississippi Drainage Basin: This huge drainage basin, extending from Minnesota to the Gulf and from Idaho to Pennsylvania, contains at the present time about 270 major reservoirs having a total capacity of 13 million acre-feet. More than one-half the total number of reservoirs and about one-third the total volume are in the Missouri Basin and are for the primary purpose of irrigation. The remaining reservoirs are scattered throughout the other sections of the drainage area, especially the basin of the Ohio River, and serve various uses; generally power production, municipal water supply, navigation, and flood control in the more highly developed agricultural and industrial regions. They also provide incidental, and in some cases direct, services for fisheries and recreational uses.

Southern and Southeastern Humid Region: In this region good storage reservoir sites are not abundant and the construction of storage reservoirs frequently involves the building of high and costly dams. The reservoirs are subject to severe floods and the serious menace of silting. The run-off is, however, large; the streams are steep; and large power output is available from regulated flow. The larger reservoirs have been and will in the future be built primarily for power production, the smaller ones for water-supply purposes. As a rule, flood control and sometimes navigation are direct or coordinated objectives.

South Atlantic States: This comprises the States of Alabama, Georgia, Florida, the Carolinas, Virginia, and Maryland. A large number of small reservoirs constructed for power purposes and a few larger ones are in existence in this region. A considerable number of major storage projects are being considered and will apparently be developed if justified by power requirement. Numerous smaller reservoirs have been constructed for water-supply uses.

Northeastern Region: This includes the Middle Atlantic, the New England, and the Great Lakes regions. Because of the deep mantle of glacial material generally overlying the rock floor, physiographic conditions affecting stream regulation differ materially from those in other regions of the United States. It is here also that the highest concentration of population occurs.

Great Lakes and St. Lawrence River Basin: The Great Lakes afford a notable example of natural stream regulation. However, the regulation is not perfect, and much is to be desired and something attainable in the way of further regulation both of lake levels and outflow. Except as interrupted by ice, the outflow of the St. Lawrence River at the international boundary ranges from a minimum of about 170,000 c. f. s. to a maximum of about 250,000 c. f. s. Regulation of lake levels and regulation of outflow are somewhat antagonistic. Still it is possible to a limited extent to accomplish something with regard to both, and because of the great commercial value of lake navigation, lake-level regulation should be considered of equal importance to regulation of outflow.

Regulation of Lake Erie in conjunction with restoration and redistribution of flow at Niagara Falls demands immediate attention as does also restoration of the levels of Lakes Michigan and Huron to compensate for the lowering of the outlet channels by dredging and channel improvements.

As regards interior streams in this district, ground water is abundant and the streams are naturally regulated to an unusual degree thereby. There are also numerous lakes which contribute to this regulation. In part, the regulation afforded by lakes has been increased and it can be increased to a much greater

degree. Power development has been quite fully carried out on most of the interior streams and further increase in available power would come largely from increased regulations.

North Atlantic States: This section includes the greater part of Pennsylvania, the Susquehanna in Pennsylvania, and Hudson River drainage in New York, and also includes the New England States. This section is mostly underlain by glacial deposits. Large reservoir sites are common in existing or abandoned glacial lake valleys, and large volumes of water can often be impounded with dams of small or moderate height. Practically no silting occurs. The run-off is large and the conditions excellent for stream regulation. However, lands required for flooding are often valuable, although many of the larger reservoir sites are in mountainous regions and in such cases lands required may be at present little developed. The cost of acquisition of flooding lands is often greatly increased by the existence of trunk highways, railroads, and buildings within the flow lines. Existing major reservoirs developed principally for power in this section have a capacity exceeding 5 million acre-feet.

Large reservoirs have also been constructed for water-supply uses for the numerous large cities existing in the region and the surrounding territory, including Boston, Providence, New Haven, Hartford, Worcester, Springfield, and Albany. Existing reservoirs for water supply for these larger cities alone have an aggregate capacity of 7 million acre-feet.

Studies thus far made indicate additional storage available mainly for power exceeding 4 million acre-feet. This figure relates, however, primarily to storage reservoirs on principal streams, and does not include the possibility for existence of more or less complete regulation by storage on nearly all principal tributary streams.

Planning Future Storage Regulation

Storage regulation of streams has heretofore most commonly been on the basis of expediency. Those reservoirs have been built which could at the time be constructed most cheaply to meet immediate requirements for a given purpose, often without regard either to (a) necessity of stream regulation for other purposes, or (b) the manner in which the particular reservoir constructed would fit in with a plan for general regulation of the stream. As a result of this procedure, there have sometimes been misfit, inadequate, and partial developments of streams by storage regulation, representing investments which realize neither the highest economic results nor contribute toward the future full economic use of the stream.

Planning of storage regulation of streams is one of the most difficult and complicated problems of engineering economics. Primarily such planning must be based on individual streams as units; but in relation to some purposes, especially the production of power, regional planning is also necessary if the best results are to be attained. This makes it difficult, sometimes impossible, to determine in advance the best order of development of storage projects on a given stream.

A sound logical basis for procedure is to limit the adoption of storage projects in a given river system to those which now or at some future time would be self-liquidating or self-supporting, including due allowance for benefits which would accrue to all Federal, State, and municipal interests, and corresponding allotments of costs, as well as allowance for direct revenue returns from the use of water for power or other purposes. In the development of individual projects which meet these requirements, the order naturally to be followed would be that of economic benefits beginning with the greatest. If, as is often the case, power production is the principal source of direct revenue, it may happen that whereas the order of development would be, say, Reservoirs A, B, and C on one stream and D, E, and F on an adjoining stream, regional benefits as regards power production combined with direct benefits on individual streams may require quite a different order of joint development of the storage reservoirs.

Relation of Storage Conservation to Other Regional Planning

Regulation of streams by storage is closely related to and should be a part of future conservation and use of water resources in relation to power, water supply, navigation, irrigation, flood control, and other purposes. Practically, storage regulation becomes commercially feasible because of and to the extent to which it confers benefits. In planning conservation by storage no one use or benefit should be considered to the exclusion of others. Each should be treated on its merits in each individual case.

Academically water for potable and domestic consumption is often considered as a primary use. Practically it is a primary use only to the extent to which and when needed for this purpose. Obviously other uses should not be inhibited nor should large drainage basins be reserved for this purpose where only a part of their yield is required. In the humid regions a population of 100,000,000 persons could theoretically be supplied with plentiful water for potable and domestic uses to the extent of 100 gallons per capita per day from the regulated run-off from say 10,000 square miles of drainage area. This is less than the area of one average State out of more than 20, so that not to exceed about 5 percent of the natural water resources in the eastern part of the United States is likely ever to be required for public water supply.

The construction of storage reservoirs almost invariably requires extensive flooding of land. One of the most difficult problems of conservation by storage is to reserve sites valuable for storage without undue conflict with other economic uses of land. This requires joint planning. The flooding of land already highly developed agriculturally or industrially, or occupied by railroads, resort camps, and other enterprises involving large investments, is out of the question. Lands in use agriculturally may so continue until needed for storage. Much land within storage basins capable of future development is poor or waste land and could appropriately be reserved without loss until needed for flooding purposes.

Legal and Legislative Aspects of Storage Regulation

Before the fullest and most efficient stream regulation by storage can be accomplished, provision must be made for the regulation of interstate streams on an equitable basis.

Intrastate regulation has been provided for in New York State by a River Regulating Act; in New England by legislation known as the New England Mill Act, and by special legislation in various other States. Conditions of legal and legislative regulations differ widely as between the eastern half of the United States, where the English common law applies to riparian ownership, and the western or irrigation region, where the doctrine of prior appropriation prevails. In particular, the Federal Government at present assumes control of stream regulation by storage only where it affects navigable waters or where public lands are involved.

While no definite plan or general legislation can be recommended at this time, it seems very desirable as regards the eastern States to have, as nearly as possible, uniform river regulating acts. Such a general act may well be patterned after the New York State River Regulating Act. In general, legislation is needed (a) to provide for the equitable allocation of water and cost to different uses particularly in cases where interstate streams are involved; (b) to provide adequate administrative organization such, for example, that water allocated to, but temporarily not needed for, one purpose may be utilized for other purposes; (c) to provide for limited reservation of important storage reservoir sites by restricting the use to purposes not requiring large investments.

PART III—SECTION III
SPECIAL ASPECTS OF WATER RESOURCES

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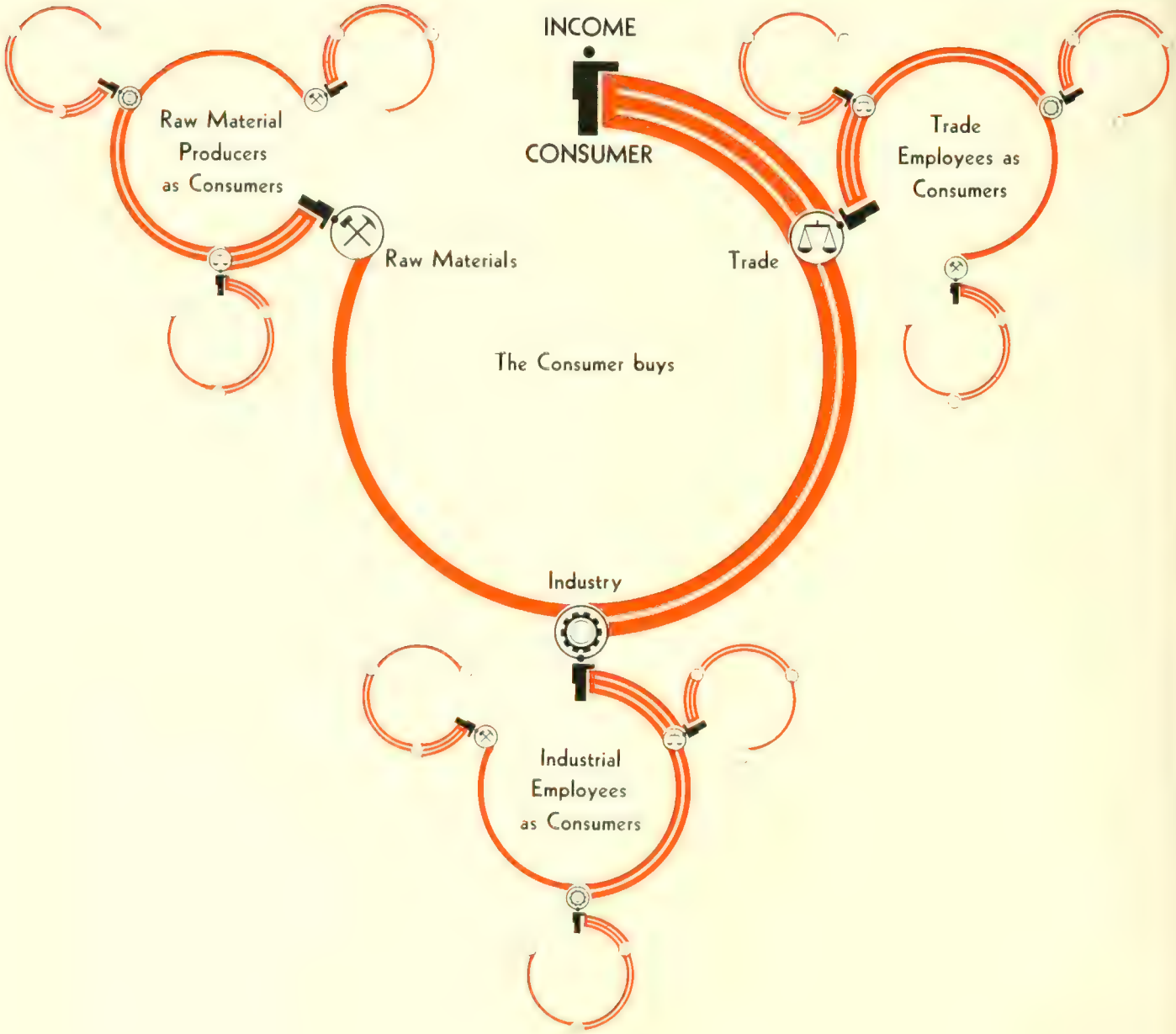
One Consumption Expenditure Starts Many Income Cycles



SECTION III

I. IDENTIFICATION OF BENEFITS FROM PUBLIC WORKS

By E. Johnston Coil

Background of the Problem

In its studies of the use and control of water resources the committee has emphasized its judgment that realization of optimum benefits can come only from the treatment of waters as a factor conditioned by a system of relationships. There are involved climatic, topographic, soil, vegetative, and other physical factors, man's modifications of some of these, and many of man's institutions. Realization of optimum benefits requires planning of an order which takes into consideration all such relationships.

Some benefits are immediate, tangible, and measurable, such as the power delivered by a turbine or the preservation of an item of property from destruction by a flood. There are, however, other benefits which are less immediate, tangible, and measurable—or even so remote as to appear to be intangible and immeasurable. It is with these that we are here primarily concerned.

The development of a resource is never for the purpose of going through the motions of the development itself. One cultivates a bit of soil for subsistence and to exchange the surplus for other commodities or services. One generates power to sell or to fabricate something which may be sold. One preserves a farm, store or factory from floods because they are instruments for producing goods or services which may be sold. They have little value otherwise; this is indicated by the custom of valuing properties on the basis of the income they yield. Therefore income—the dynamic flow of goods and services—constitutes the real, the basic, benefit. The details of economic activity of an entire society are, from the point of view of present facilities for delineation and measurement, intangible. But because they are the fundamental benefit, it is urgent that studies in delineation and measurement be promoted on a large scale if we hope in general to achieve rational planning, and in particular to achieve equitable allocations of benefits and contributions to cost in public works programs. In the meantime we must be dependent on circumstantial evidence, which does, however, throw considerable deductive light on the problem.

We are accustomed to think and evaluate things in terms of money. But money is only a symbol that for convenience of exchange effaces all qualitative differences between commodities and services. Consequently business becomes concerned with numerical abstractions and the realities are lost. We know, however, that the only basic reality is the actual goods and the actual services that satisfy our needs. These real goods are but natural resources modified by human energy. Work applied to resources creates goods;[1] goods serve to preserve and develop life with its needs and demands; these needs and demands, in turn, further stimulate the application of labor to resources.

The Problem

As all goods in the processes of production and distribution pass from hand to hand and from ledger to ledger, the very number of transactions in terms of the abstract money symbols becomes bewildering and intangibility enters. The so-called tangible losses and benefits in a particular situation are those goods and services immediately discernible and measurable in that situation; the *intangibles from the point of view of that same situation* are, however, similar goods and services one, two, or three steps removed in the business system of purchase and sales. They are just as tangible and measurable in their situations. However, hidden by price transactions and specializations of function they cannot easily be evaluated except in their situations.

The first step in measurement is identification. The problem is one of identifying and portraying in terms of goods and men what actually does occur in the complex series of transactions conventionally presented in price terminology. Before any attempts can be made to measure the ramifications of expenditures on water projects, and the ramifications of losses prevented, we must first literally see in their remotest manifestations what is to be measured

Two Underlying Economic Processes

Consumption Goods and Production Goods. The goal of economic activity is consumption, which is the conservation and expression of individuality. At first man seeks to satisfy his needs by applying his own limited energy to physical resources. Later—this indicates the emergence of technology—instead of devoting all his energies making consumption goods, man takes part of his time and part of his resources to build machines and tools to aid him in converting resources. These production goods enable him to produce more consumption goods in a given period of time; enough to more than repay him for the labor of building the equipment that unlocks and utilizes nature's energies. (See diagram Production Equipment Increases Output.)

Production equipment never passes out of the producing system to be directly consumed, for in itself it can satisfy no human need. Only the final consumable goods which it makes can flow out into consumption. However, a new machine, because it helps to produce them, represents potential consumption goods, and a worn-out machine represents the realization of these goods. In a system of power production, a vast series of specialized production-equipment processes lie between the natural resources and the finished consumable goods. There is specialization of labor and of business enterprise not only in making and exchanging consumption goods, but also in making and exchanging the materials and equipment goods essential before final consumption goods come into existence.

Flow of Purchasing Power: As, in reality, we exchange goods and services only for goods and services, any increase in the total amount of goods and services makes more exchanges possible. Purchasing power—ability to buy goods—is the ability to make exchanges. Although exchanges are effected through the medium of the symbol money, money is obtained by making a contribution to the production of goods and services; therefore purchasing power and the physical quantity of goods produced are two aspects of the same thing.

When a new increment of goods is made and added to the world's supply, and money symbols for goods are placed in active circulation, the total income is increased by more than the original symbols expended. The total income eventually

[1] "Nothing whatever enters or can enter into any product other than human activity applied to natural resources. * * * It is the final bedrock fact in the natural economy of human life. The solution of every economic difficulty has to be sought, not in business or finance procedure as a thing in itself, but in the relation of this procedure to the ultimate reality."

Fred Henderson, "Money Power", pp. 26, 27.

created exceeds the original initiating expenditure. Between natural resources as raw materials and finished consumable products there are many exchanges—a long sequence of intermediate stages of stimulated productivity, at each of which bits of things are created and contributed to the final consumption goods.

An expenditure by a consumer stimulates an increment of economic activity which passes through each stage of specialization from retailer back to raw material. At each stage part of the expenditure is retained as income, so that when the expenditure reaches the providers of the raw materials, all of the expenditure has become income. All intermediate participants now have income which they otherwise would not have had. Each has wants to satisfy; each makes expenditures he would not otherwise have made; and together a corresponding number of new circuits of exchange is started which stimulates new productivity and gives income to many other groups of producers. (See diagram, One Consumption Expenditure Starts Many Income Cycles.) The total income and purchasing power created is equal not merely to the initial expenditure but to that amount multiplied by some coefficient of the number of times the money passes annually through the sequence of production from the final goods to the natural resources.

Benefits from the Construction of Public Works

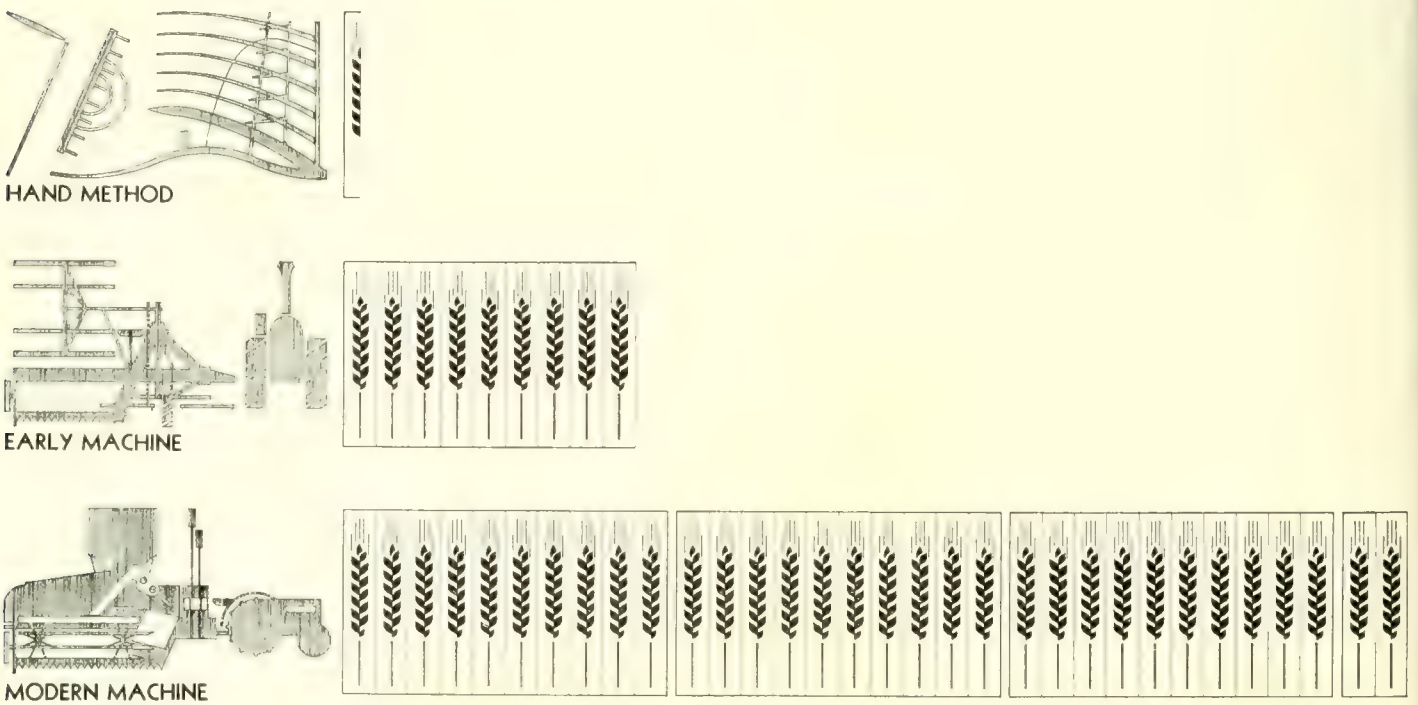
The benefits of a public works project are of two kinds: The benefits created when a project is being constructed, and those created after the project has been completed and is operating.

During the period of construction a public works project is a market for labor, services, equipment, materials, and supplies. Later, when operating, it will produce goods or services for exchange, but during the construction period the project only consumes. The money used to build the project goes to buy materials and equipment, to pay laborers, and to employ engineers and others responsible for construction. These expenditures for labor and goods, if derived from idle funds, bring into existence something which otherwise would not come into existence; work is created for men otherwise unemployed and materials and goods are produced for which there would otherwise not be a demand. These funds, as they initiate exchanges of goods and services, stimulate an addition to the business activity prevailing, and they begin circulating throughout the entire business system as an object dropped into quiet water starts rings of waves which become larger and larger and extend far from the original point of impact.

The employment created by men working directly on the project is obvious because it can be seen by anyone visiting the project. But the distant employment required to make the materials and equipment, and to transport them to the project, is not obvious to the visitor. Each bit of equipment and material used on the project was once a natural resource, and each time a piece of material passes from process to process in the chain from natural resource to finished product for the project, the number of transactions is increased and income is passed along the line of production and distribution. Without the orders for equipment and materials, labor would have been idle or working part time. It has been estimated that for each worker employed on the construction of the project, two are employed in mining, manufacturing, and transporting materials and equipment that are needed to build the project. These workers are as scattered throughout the country as are the sources from which each item of supplies and materials must come.

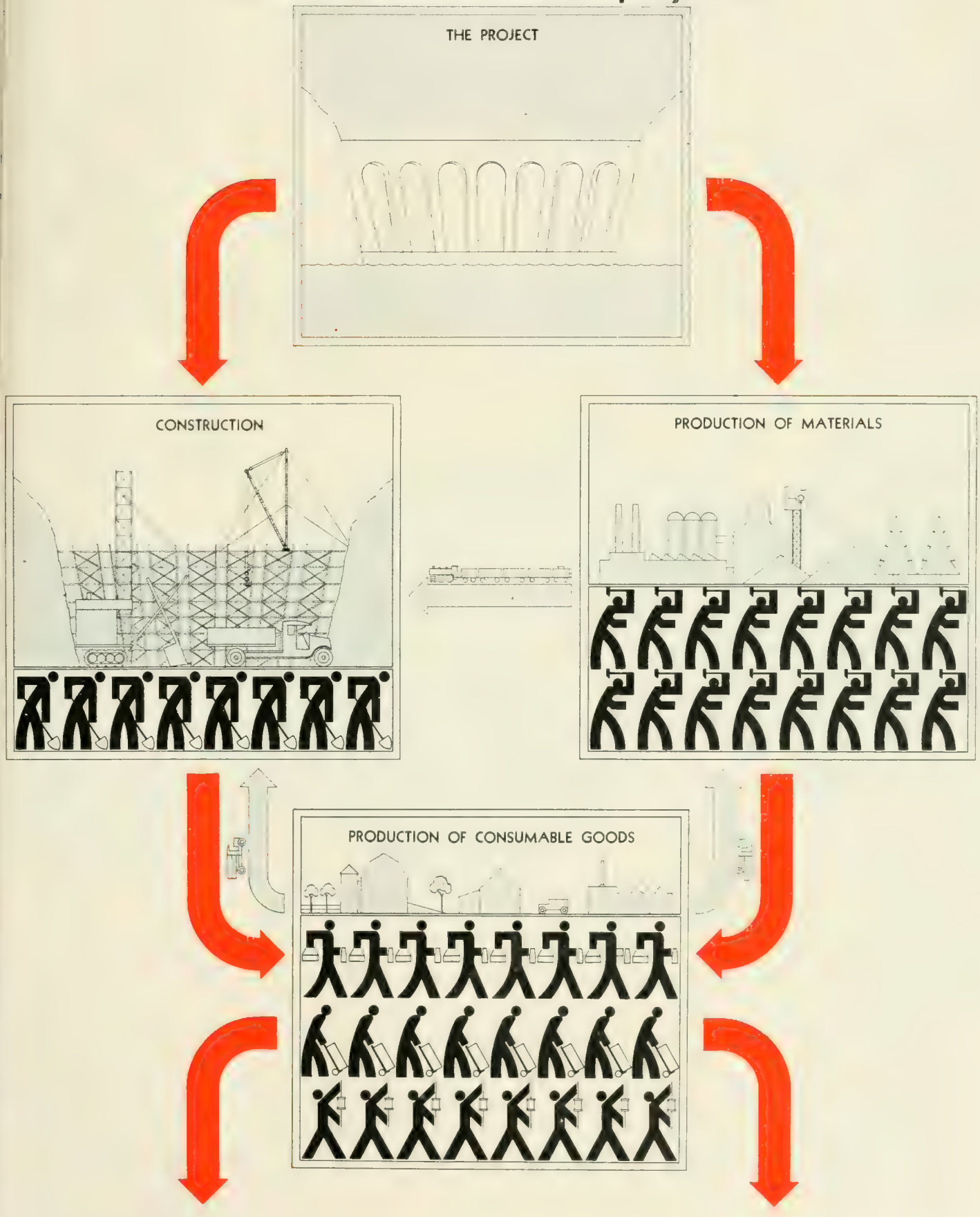
The immediate employment created by public works is the number of workers required to do all the work from natural

Production Equipment Increases Output



Each head of grain represents one unit harvested by one man per day

Public Works Create Employment



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resources to finished project. The immediate creation of purchasing power does not cease until all the funds are in the hands of individuals as payment for services and labor, and this does not occur until each item of supply and equipment has been followed back through all the processes of manufacture and fabrication to the form of an original natural resource.

The creation of employment and goods by public-works construction does not cease here. Additional cycles of work and production are stimulated because the workers, having income which they otherwise would not have had, proceed to purchase goods and thus create a demand for goods which otherwise would not have been sold. Making the goods which the workers buy creates further employment. This employment is calculated to be as large again as all the immediate employment created in constructing the project and providing materials. (See diagram, Public Works Create Employment.) Thus it is that an original expenditure creates income which, in turn, is expended to create income in a cumulative series. Because we live in a world of specialization of work and exchange of products and services, the central fact is that an expenditure diffuses in all directions in an expanding manner and stimulates new productivity wherever its influence is felt. The point is not that the expenditure itself magically becomes larger as it is diffused through channels of exchange, but that throughout the field it stimulates productive activity which would not otherwise be called into existence.

Operation of Projects

To build is not the sole aim; projects are designed to serve some purpose. Whereas the construction period represents consumption and indirect production, during the operating period the project becomes productive in its own right. The particular product or service produced by a project varies, of course, with the nature of project. However, water projects may be classified into two principal categories: (1) loss-preventing, and (2) income-producing.

A Loss-Preventing Project—Flood Control: Some projects are not designed to add to the Nation's wealth by producing goods, but to protect what has been and is being produced. To control floods is to prevent losses, so the focal point on any inquiry as to the benefits produced by a flood-control project is the nature and the type of the losses prevented, which is but a statement of the losses suffered and incurred by a typical community when it is flooded.

The Loss of Tangible Goods: As all goods represent natural resources that have been transformed by labor so that the goods have a capacity to render satisfaction or further the production of goods which will render satisfaction, such goods, one may say, are stored services, which are diminished as the goods are consumed. When goods are destroyed, the unconsumed portion of these stored services is lost. In other words, the labor and resources which had been used to make the unconsumed portions have been wasted—wasted energy, time, work—wasted lives.

(*a*) The Loss of Inventory: Each business unit, whether large or small, is engaged in the production of a product, which may be a consumable good or production equipment. There may also be certain "social" inventories. The inventory that is destroyed or damaged in a flooded community may be:

(1) Agricultural crops and livestock.
(2) Stocks of goods in wholesale and retail stores.
(3) Manufacturing inventories, including raw materials, goods in process, and finished goods in stock.
(4) Wildlife and game.

(*b*) The Loss of the Means of Production: Not only are the products lost, but also the means of production are destroyed or partly destroyed. This subclass of tangible goods is the production equipment of the area which is used to produce the product, whether the product be a good or a service. These damages and losses may be:

(1) The eroding and gullying of soil and crop land; the depositing of less fertile soils, sand, and boulders upon the land.
(2) Farm barns, sheds, agricultural equipment, tools, and supplies.
(3) Factories and production equipment.
(4) Stores, theatres, public buildings, and equipment.
(5) Telephone, telegraph, and power lines; power plants and utility service equipment.
(6) Transportation facilities; bridges, highways, roadbeds, trackage, and equipment.

(*c*) The Loss of Durable Consumer Goods: Lastly, there is a class of tangible goods which have already passed into consumer service, but which are consumed slowly because the goods are of a durable nature. Whereas food products are quickly consumed, clothing is more slowly consumed, and furniture even more slowly. Where the life-time of a consumable good is relatively long, a flood always damages and destroys such a good; particularly

(1) Houses.
(2) Home furniture and furnishings.
(3) Automobiles.

Intangible Losses: The sum of these tangible goods—products, means of production, durable consumer goods—that are destroyed and damaged represent the known tangible loss from a flood. But all these losses are the results of past production, of work applied to resources before the flood. Human life, however, is continuous. The basic condition for its survival is uninterrupted consumption and continuous production for tomorrow's consumption. This conception of the continuity of human life as the unbroken flow of consumption and preparation for further sustenance, both going on inseparably together, is the essential reality. The only real economic facts of human existence are the ability to create and the capacity to consume. The opportunity to do either is irrevocably lost with the passage of time. Human energy, if not exercised, can never be productive work; consumptive capacity, if unfilled, can never be satisfied.

A flood interrupts this sequence of producing-consuming activity. If the destruction does not occur, enforced idleness will not develop and the conversion of energy for the production of goods and services will continue. Such losses occur not only in the area flooded but throughout the Nation.

Whereas the loss of products in the flooded area represents the destruction and damage to goods that were ready for sale and exchange, the loss of production is the products which could but never have come into existence, the turnover of merchandise which could but never has taken place. It is equivalent to the economic activity which would have taken place if the interruption had not occurred, such as:

(*a*) The crops not planted.
(*b*) The manufactured products not produced.
(*c*) The reorders by the retail stores not placed.
(*d*) The telephone calls not made; the telegrams not sent; the power not consumed.
(*e*) The transportation service not utilized.

The area flooded does not live isolated from the rest of the Nation. Each day goods and services are being exchanged; supplies, equipment, and consumable goods produced within the area were being shipped out and other goods shipped in. The area is a producer of its own products and a market for others. But as the flood destroys products and stops production, nothing becomes available for exchange. Sales stop; therefore purchases also stop; therefore certain production outside the flooded area stops. (See diagram, Flood Disrupts Economic Life.) The

Flood Disrupts Economic Life

workers who are making goods which would have been sold in the flooded region do not have as much income and hence are unable to buy the products of other workers, and so another sequence of the chain from consumption of final goods to the natural resources is interrupted. Just as the construction of public works spreads activity and income throughout the Nation, so the flood spreads inactivity and loss of income.

There are those, however, who assume that the market is not lost, because relief expenditures keep the people in the flooded area consuming. This, however, is completely offset. The people who donate funds to the Red Cross have less to spend for other goods; the funds spent by the governments mean less expenditures in other normal functions, and mean higher taxation. Relief expenditures do not reduce the loss of business activity; they merely further spread and diffuse the loss over the Nation.

An Income-Producing Project — Hydroelectric Power: An income-producing project is one which brings into existence goods or services—benefits—which heretofore did not exist. The problem is one of measuring gains rather than losses. The benefits arising from the construction of a project all apply; but in addition there are operating benefits with which we are not concerned.

Tangible Benefits: Man may dream and wish for innumerable satisfying goods, but the only method of creating these goods is that of applying energy. Through the power created by controlling the energy in flowing water, a gain in productivity—ultimately consumable goods—is realized. These measurable productive benefits extend to an area coterminous with the users of the power, which may be an area of considerable extent.

The enlarged output of goods measures the increase of consumer income. Existing enterprises produce an additional increment of goods, and new enterprises may be established. Rural electrification may reduce the man-hours of work for the farm family, and a consumer gain arises from the enlarged amount of leisure time without sacrifice of productivity. This leisure time is creative in that it stimulates the consumption of goods and services. The capacity to consume the larger output of goods made possible by electric power production is dependent not only upon the capacity to produce, but also on the ability to appreciate and utilize that which may be produced.

Measurable Intangible Benefits: Many intangible benefits arise outside of the area directly using the hydroelectric power. Like the intangibles in the flood-control illustration, these benefits are really tangible and measurable in their own situations. As the output of goods and services increases in the power-consuming area, the opportunity for effecting exchanges between areas increases. The production activity required to supply the growing market creates markets for other producers, and the activity of producing and exchanging diffuses throughout the Nation.

The Immeasurables

Many benefits and losses defy measurement. Man's conceptual scheme of himself and his relation to his environment are among these incalculable elements. In planning for the conservation and utilization of natural resources, a new plane of approach and appreciation is attained. Inherent within public-works projects devoted to conservation and creation are visions of an organic unity between man and his resources, of a perpetual rather than an impoverished environment.

This enlarged conception has as its basis the realization that man is the center around which all economic activities circulate and by whose needs and interests all are judged. Because many benefits do not have monetary equivalents, they are disregarded in reports which consider only the calculable items. The immeasurable benefits, however, should be included as a factor in any evaluation procedure. It seems that they are becoming so. The present Public Works program is but an expressed recognition of their existence—of the reality that every man has the social right to work and that the one evil greater than enforced slavery is enforced idleness.

Creative Research

The foregoing analysis and exposition is admittedly based on circumstantial evidence—inferences from isolated researches—but its major elements are in accordance with understanding of economic processes. As was observed earlier, one of the most important areas of research lies in this field. An adequate study of the order indicated would have to be on a vast scale, and would require substantial funds and skillful organization; but the significance of the results as a basis for determination of many aspects of social policy would justify it.

SECTION III

II. COSTS AND UTILITIES OF WATER AND LAND TRANSPORT

By Stuart Chase and Robert Lesher

The prime justification of transportation, from the national point of view, is in supplying the Nation with the essentials of a good life. These essentials no longer come from a single locality, as they did in the handicraft age, but from all parts of the country, and indeed from all parts of the world. If transport in the United States should suddenly be paralyzed, it is doubtful if as much as half the present population could long remain alive. Some metropolitan centers, it has been estimated, have no more than 48 hours' supply of food on hand. The transport service is thus peculiarly affected with a public interest, and that interest applies to all forms of transport, for all are an integral part of the transportation system.

To provide survival needs and a modicum of recreation, the service is now called upon to move nearly 100 millions of citizens to and from their work and their play, over a greater average distance than has ever before obtained; and to move annually the equivalent of half a trillion tons of commodities 1 mile. It is true that there is much crosshauling and other forms of waste in the present total. Also, the heavy and bulky commodities which have been moved to construct the Nation's industrial plant in years past have accounted for an unreasonably high ratio as compared with the necessities of life, which are consumed daily.

The plant through which this stupendous amount of energy flows to effect the physical distribution of people and goods consists of:

Natural waterways: Inland streams, lakes, and the sea.

Artificial waterways: Canals and canalized rivers.

Railways: Intercity and local; subways, surface, elevated lines.

Highways: Passenger cars, trucks, and busses; here and there a horse and wagon.

Pipe lines: Trunk and feeder.

Airways: Dirigibles and airplanes.

Cableways: Cars moved by gravity and power.

Transmission lines: For electrical energy only.

Transfer interchange: Escalators, moving platforms, belt, bucket, and rack conveyors, cranes, tractors, and trailers, chutes, derricks, elevators, inclined planes, numerous other mechanical devices.

A measure of the performance which this plant is annually called upon to render has been estimated by Commissioner Joseph B. Eastman for the year 1932, as follows:

	Ton-miles	Percent
Railroads	235,309,000,000	73.9
Intercity trucks	29,977,000,000	9.4
Great Lakes shipping	24,734,000,000	7.8
Pipe lines—petroleum	19,600,000,000	6.2
Inland waterways	7,905,000,000	2.5
Electric railways and airplanes	583,000,000	.2
Total	318,108,000,000	100.0

To this must be added local trucking, coastal shipping, the movement of freight from coast to coast via the Panama Canal, transport of gasoline and natural gas in pipe lines, the carriage of mails and parcel post. The grand total is probably not far short of 500 billion ton-miles—a figure for which the railroads alone accounted in 1929.

The traffic moves over the following rights-of-way, their distances in round figures being:

	Miles
Highways (700,000 miles surfaced)	3,000,000
Railways (main track only)	250,000
Pipe lines (including trunk and feeder lines)	190,000
Inland waterways (rivers and canals)	27,000
Airways	25,000
	3,492,000

The manpower serving transport is exceedingly difficult to arrive at for some divisions. Moulton makes the following estimate for the year 1930:

Highways, truck and bus service	2,500,000
Railways (high for 1930)	1,500,000
Inland waterways	200,000
Pipe lines	22,000
Airways	6,000

To which should be added, from the Statistical Abstract for 1930: Electric railways, 177,000. The total number of highway road workers has been estimated at about 1,000,000.

The transport equipment, again in round numbers, is:

Private automobiles	22,000,000
Trucks	3,500,000
Trailers	350,000
Taxicabs	140,000
Busses	100,000
Freight cars	2,300,000
Passenger cars	50,000
Locomotives	60,000
Inland waterway towboats (propelling units)	1,300
Inland waterway barges	4,500
Airplanes (1931)	10,050

In addition there are steamboats, motorboats, sailboats, Great Lakes equipment, coastal waterway equipment, loading and unloading devices. Nor should it be forgotten that the horse and wagon is still a substantial element of transport in many rural areas, and in some metropolitan trucking.

Investment in transport facilities, exclusive of transmission lines, has been appraised as follows:

	Billion dollars
Highways and highway facilities	28
Railroads	26
Electric railways	3
Waterways	2
Airways	1
Pipe lines	1
Total	61

This is a figure undoubtedly far in excess of that demanded by the current traffic, even before the depression. The net increase

in investment for the various agencies from 1920 to 1932 is reported by Mr. Eastman:

Highways (roads only)	$12, 500, 000, 000
Railways	6, 309, 000, 000
Waterways (channel only)	604, 000, 000
Oil pipe lines	424, 000, 000
Street railways (shrinkage)	(727, 000, 000)
Net increase	19, 110, 000, 000

Adding to this automobiles, trucks, garages, boats and barges, air ways, aircraft, natural-gas pipe lines, gasoline pipe lines, electric transmission lines, Mr. Eastman estimates a grand total increase in transport investment since 1920 of at least 25 billions of dollars.

During this period the motor car, airplane, water, pipe, and transmission lines tore from the railway its sometime claim of being *the* transportation system. The plant has doubled its capacity in the last 15 years, but population has increased only one-sixth and physical productivity 4 percent. The inevitable result has been excess capacity. That this capacity is in excess of human need has not been determined; it is thought highly improbable. That it is in excess of effective market demand is plain to all, and has led to a condition of competitive chaos.

This plant and its equipment differ from the facilities for agriculture, mining, or manufacturing, in that the product, being a service, cannot be stored. It is dynamic; it moves; it must be used. No portion of the output can be piled on the shelves or laid in the warehouse. Once built, the plant must be operated to keep healthy, and it is not now being so operated.

In these unhappy circumstances the community must take immediate and drastic steps to preserve itself. A breakdown in transport is a contingency too monstrous to contemplate. The appointment of Mr. Eastman as Federal Coordinator is one such step. Mr. Eastman regards the service of transport as one organism, with each agency performing certain functions for which it is peculiarly fitted. Granted this philosophical base, the next task is to discover the advantages and limitations of the several agencies, decide in what fields they can render the most useful service. This involves a study of comparative utilities and of comparative costs.

Obviously such a study can have little in common with customary financial considerations. That these matters are important is not to be denied. At the moment the prime interest of the community is in physical utility and physical cost to the end that the plant may function. The problem is one of engineering rather than of corporate finance. This point of view, furthermore, holds good for any long-range planning developed by the community in years to come.

Mr. Eastman says:

> Each form of transportation—rail, water, highway, pipe line, and air—can perform certain services more cheaply or more efficiently than can any of the others. It should be protected in such service against destructive competition by the others, and at the same time provision should be made for easy interchange and the establishment of through rates and joint rates where such coordination is desirable.

What is cost from the public standpoint? It is the energy and materials used up in producing a given commodity, or rendering a given service. Energy may be subdivided into animate and inanimate—human effort and diligence, and power obtained from fuel and electricity. Both inanimate energy and materials require human effort or diligence to make them available.

The accountant produces his cost sheets for manufacturing a keg of nails or a radio set or a box of pencils, and the business man endeavors to set a price which will cover the cost and leave a profit. But price and cost are given in dollars and cents. From this frame of reference only, that of private business, the procedure is useful and necessary.

But from the standpoint of the whole Nation a new frame of reference becomes necessary, and the calculus changes. No trading advantages, no expenditures for capturing markets, no outlays for vested rights or vested interests, can possibly come into the picture. Furthermore, in terms of long-range planning, the dollar is a most unreliable guide to cost. Dollar costs must be cut under to physical costs if the community is ever to judge the relative utilities of its transport agencies.

The phrase *human diligence* is now being employed instead of *human labor*, in that under modern power-age methods the worker is increasingly called upon to watch and supervise the process, rather than to exert foot-pounds of energy in carrying it to completion. If one can divorce himself from the business profit and loss account for a moment, and visualize the physical events which take place when a person or a commodity is transported, all that happens or can happen in time and space, is that certain materials are depreciated, a certain amout of inanimate energy is consumed, and a certain number of man-hours are expended. Pushing the analysis one step further, it is evident that the materials have originated in the earth, sea, or air, and cost nothing to extract but the effort of man. God makes no charge for natural deposits in the raw. They warrant, however, consideration of the factor of conservation for diminishing assets.

For practical purposes, physical costs may be measured, appraised, and compared in terms of man-hours. Alford and Hannum have blazed the way by their computations in terms of thousand (kilo) man-hours, or more briefly, k. m. h. units. They write:

> Productivity is the rate, speed, or velocity of performing work. The rate of industrial production can be measured just as the speed of a moving automobile is measured. Both measurements are time rates of doing work. The speed of an automobile is expressed as miles per hour. The speed of industrial production may be expressed as the rate of the quantity of product output per man-hour worked * * *. If the automobile travels a distance of 90 miles in 3 hours, the rate is 30 miles per hour. If an industrial plant produces 140,000 tons of castings during a year when 10,000,000 man-hours or 10,000 kilo-man-hours are worked, the rate of production is 14 tons per k.-m.-h.

Cost, so measured, will vary widely, of course, according to the technology of the process. As technological methods improve, the man-hour method of cost finding will register the gain with an exactness which no money method can approach.

We have reached a point in this country where the man-hour cost of most essentials is the lowest in the history of mankind. The only proof needed is the extent of the overhead establishment supported by the surplus. As a matter of fact, the true physical cost of living, measured in man-hours, is now probably a half or a third of what it was in 1830. This is a significant fact, but few have ever been aware of it. Transportation is of cardinal importance in the changed methods whereby survival needs are met.

Obviously we have not yet the data to reduce all costs of production, still less of services like transport, to a man-hour basis. It is possible, however, to obtain a rough index of comparative k.-m.-h. by estimating the active labor power in each part of the transport service, and dividing it into the total ton-miles moved. For example:

Output in ton-miles per 1,000 of man-hours worked

Man carrying a pack	50
Man pushing a wheelbarrow	100
Intercity trucks, 1932	20, 000
United States class I railroads:	
1931, all labor	101, 500
1931, freight labor	171, 000
United States inland waterway corporation, 1932–33	213, 000
Pipe lines reporting to Interstate Commerce Commission, 1932	504, 000

Turning the figures around, we can secure a man-hour cost for a ton-mile moved:

Active man-hour cost per 1,000 ton-miles

	Man-hours
Man with a pack	20,000.0
Man pushing a wheelbarrow	10,000.0
5-ton truck (driver and service labor)	50.0
United States class I railroads:	
All labor	9.8
Freight labor	5.8
Inland waterway corporation	4.7
Pipe lines	2.0

Unfortunately these figures cannot be called the true man-hour cost, because they include only the labor of those actively engaged in the service, and *not* the labor of those who furnished the materials, or the amortized labor of those who built the plant, or the labor cost of producing the necessary grades of skill. Data are not yet available to calculate the latter items.

More pertinent still from the public's standpoint, is the concept of physical *utility*. This includes cost, but embraces also four other factors—time, distance, weight, volume—all measurable in exact quantitative units. It may cost less in man-hours to ship livestock by rail, but the *time* saved by truck is often a more important consideration.

Transport service is basically an energy performance. Its efficiency must be measured in energy units if true utility is to be determined. Work done, in the engineering sense, is weight moved through distance, which is usually expressed in foot-pounds. Power, on the other hand, is the rate at which this work is done, or the number of foot-pounds that can be moved in a given unit of time. This is usually expressed as horsepower. The elements of weight, distance and time, therefore, are cardinal in expressing transport performance in energy units. One additional unit is required to complete the picture. This is volume, expressed usually in cubic feet of space.

An example will tend to clarify the use of these units. Every vessel has a water line above which it should not be loaded, for reasons of safety. It can be loaded with steel rails until it settles to this line, in which case, there would be cubic space unused. On the other hand, it can be loaded with rattan or baby carriages until every bit of cubic space is utilized, without sinking to the water line allowed by law. The ideal condition which every ship operator seeks is to have such a selection of commodities that when the ship is fully loaded it will be both "full and down." In shipping, therefore, weight and volume are paramount, common practice being to accept freight on a basis of either weight or volume. A crated piece of machinery is weighed and charge accordingly. Bundles of bamboo, however, are measured to determine the number of cubic feet of space they will occupy when in the hold, 100 cubic feet of space being taken as the equivalent of 1-weight ton. This formula renders the calculation or rates on the high seas exceedingly simple, in sharp contrast to the maze of rates found in our present railroad operations, where there are different systems of class rates and the number of commodity rates approach infinity.

When we add to this weight-volume concept the distance to be traveled, and the average speed or rate at which the ship moves, and the cost of the movement, preferably expressed in man-hours, we have a series of quantitative expressions which tell us all the important things there are to be known as to the transport performance, or utility, of this ship and its load. The unfortunate thing today is that records of carriers and of their regulatory agencies are usually expressed in terms of weight only, or time, or distance (seldom volume or man-hours), but never in terms of *all 5 units*. Until we secure such records, work done cannot be calculated, and hence the relative advantages and limitations of the various forms of transport cannot be adequately ascertained.

We now proceed to an examination of such comparative cost material as we have been able to unearth, with certain specific warnings. The figures are often in money terms; frequently covering different years when the value of the dollar was shifting. They are incomplete, often highly specialized, and likely to be crawling with propaganda, especially on behalf of railroad and antomotive interests. Mr. Eastman is now at work on what promises to be the first thorough study of comparative costs, but the results are not yet available. From what we have been able to learn of this study, however, its basis will be financial rather than physical costs. They will probably be among the least biased money costs ever calculated, but they are not likely to furnish data for physical costs.

The accompanying table sets forth the major items of expense for each transport service. Though the basis is money expended, the table gives us a clear picture of the kind of items found in each service, and their relative importance. Business expense, such as interest, insurance, taxes, traffic-getting outlays, have been excluded so far as possible.

Major items of expense

Classifications	Railway	Waterway	Highway	Pipe line
	Percent	*Percent*	*Percent*	*Percent*
Transportation, including terminal operation	46.0	62.7	37.2	14.0
Maintenance of equipment	26.6	21.4	19.3	71.3
Maintenance of way and structures	18.7	---	---	
General expenses	8.7	15.9	43.5	14.7
Total operating expense	100.0	100.0	100.0	100.0
Depreciation of equipment	5.5	10.7	10.7	55.0
Depreciation of way and structures	.3	---	---	
Total depreciation	5.8	10.7	10.7	55.0

Major expenses in order

RAILWAY, 1929

	Percent
1. Repairs to locomotives	9.1
2. Repairs to freight cars	7.5
3. Station employees	6.6
4. Fuel for train locomotives	6.2
5. Trainmen	5.8
6. Enginemen—train	5.0
7. Track laying	4.2
8. Brakemen, yard	3.5
9. Depreciation, freight cars	2.6
10. Ties	2.1
11. Enginemen, yard	2.1
12. Clerks, general	2.1
13. Train supplies	2.0
14. Roadway maintenance	1.7
15. Repairs to passenger cars	1.7
16. Train engine house expense	1.7
17. Superintendence of transportation	1.5
Total	65.4
All other expense	34.6
	100.0

PIPE LINE, 1932

	Percent
1. Depreciation of line and equipment	55. 0
2. Maintenance and repair	14. 7
3. Loss and leakage of gasoline	12. 3
4. Power and fuel	10. 6
5. Labor, pumpers	3. 4
6. Superintendence	2. 4
7. Labor, line riders	1. 6
Total	100. 0

WATERWAY, 1933

1. Labor at terminal	14. 5
2. Crew wages	10. 6
3. Depreciation of vessels	10. 3
4. Fuel	9. 8
5. Repairs to vessels	9. 2
6. Clerks at terminals	7. 2
7. Other terminal expenses	2. 9
8. Clerks, general	2. 8
9. Tugs and lighters	2. 7
10. Superintendence of traffic	2. 5
11. Maintenance of terminals	2. 2
12. Superintendence of terminals	2. 1
13. Food for crews	1. 6
Total	78. 4
All other expense	21. 6
	100. 0

HIGHWAY, 1932

1. Drivers' wages	20. 9
2. Overhead wages and salaries	18. 4
3. Overhead miscellaneous expense	13. 3
4. Gasoline	11. 0
5. Depreciation of trucks	10. 7
6. Repairs and maintenance	8. 6
7. Tires and tubes	4. 0
8. Rent, garage, etc	3. 6
9. Oil and grease	1. 3
Total	91. 8
All other expense	8. 2
Total	100. 0

The first thing to be noted in this table is that neither waterway nor highway accounts as customarily rendered include anything for maintenance of way, an item which looms large in railway expenses—about 19 percent of all operating charges. Here, of course, is the reason for the railroads' outcry against subsidies. Initially it should be pointed out, however, that trucks do contribute large sums to highway maintenance indirectly by their payment of license fees, property taxes, and gasoline taxes. These amounts vary widely from State to State, and are never included on the trucker's cost sheets as maintenance of way. The large percentage for highway overhead shown in the table (43.5 percent), does not include these payments, as we have excluded them, but rather is accounted for by administrative wages and salaries of the truck fleet, garage rent, and miscellaneous expenses.

The next thing to be noted is the relatively low ratio for depreciation on the railway as compared with all expenses, and the very high figure on the pipe line. The depreciation of way and structures on the rails is only 0.3 percent of all expenses, indicating that the right-of-way is kept practically at par by maintenance expenses charged to current profit and loss. An examination of the major single items confirms this, where we find track laying as the seventh largest expense, ties as the tenth, roadway maintenance as the fourteenth. The pipe line, on the other hand, is primarily an automatic pumping device, requiring very little labor—and most of that diligence—55 percent of all its expense being depreciation. These figures bring out clearly the distinction between the railroad as a machine age product, and the pipe line as a product of the power age.

Repairs to locomotives and freight cars ranked nos. 1 and 2 among single railway items in 1929. In recent years these repairs have fallen off somewhat. The ranking item in the barge line is terminal (dock and wharf) labor—and much of this *is* labor. No. 2 is crew wages, another labor item. Similarly for the truck fleet, no. 1 is drivers' wages, no. 2 overhead wages and salaries.

Certain of these items can readily be reduced to man-hours; certain others, like fuel, can be estimated in equivalent man-hours, but many, involving depreciation, the purchase of materials and supplies, overhead services like postage and telephone, cannot be so reduced at the present time. The information will not be available until k. m. h. or similar studies are developed for each stage in the industrial process—from mine and farm to finished product.

Increasing competition has resulted in a hue and cry against unfair subsidies. The railroads claim that the Government provides free channels, roads, and airways for their competitors to run upon. The competitors counter by pointing to huge land grants to the railways in years past, to which the railroads reply that they carry Government traffic at half the scheduled rates. The charges are often accompanied by elaborate cost sheets. The whole truth is not in them. Even from a strict financial accounting point of view, they do violence to the accepted theories of cost. The student might be submerged by these torrents of figures, if he did not cling to the steady hand of the physical cost concept. Applying this frame of reference to the evidence presented, certain broad conclusions can be drawn.

The Government does in effect subsidize the waterways, but the "hidden costs" compiled by antiwaterway computers are far removed from the physical facts. The heavy surcharges for "equivalent interest", "equivalent taxes", have no place in a *physical* cost sheet. Amortization of channel outlays has a place, but unfortunately the War Department has never kept its records so that navigation can be differentiated from flood control, national defense, and other outlays. Maintenance of the channel certainly has a place, but again how shall it be segregated from current flood control? Nobody really knows. Again, it is futile to ask any community to scrap a waterway because a lot of money was spent in building it, and an amortization of the principal, applied to current operations, results in a high waterway cost per ton-mile. This is carrying the calculus of profit and loss to fantastic lengths. The waterway is built. It should be abandoned only if its utility is small, or its maintenance cost, when apportioned to current traffic, abnormally high. The same principle applies to railways and highways. *Maintenance*, not amortization of something which has already been constructed, is the deciding factor.

It is a wide-spread opinion that some waterways can legitimately be abandoned on these grounds. More important, proposed waterways should be most carefully assessed for physical cost and utility. Millions of man-hours have been thrown away in the past because of failure to use these criteria.

The State also grants, in effect, a subsidy to the truck and bus. It has been calculated that on a good two-lane concrete road, this subsidy does not exceed $22 per year per vehicle, disregarding interest as an element of cost, and does not exceed $80 including interest. The subsidy for a busy commercial truck with its annual operating expense of $3,000 or more is thus small.

If it be objected that the truck cracks up the highways, Mr. Eastman, the Bureau of Public Roads, and various other experts reply that trucks up to 4 tons on pneumatic tires have little effect on concrete roads. They do crack up softer roads, and have in the past caused an extra expense in all highway building of perhaps 15 percent. It must be remembered, however, that most trucks are private and not common-carrier competitors of railway or waterway, and that motor vehicles are now paying on the average about $43 a year in licenses, gasoline taxes, and property taxes, towards the support of the roads. The case against the highway subsidy is, in our opinion, weak, and growing weaker as more concrete roads are build, more pneumatic tires installed, more taxes and license fees paid.

The financial costs of the several transport agencies which we have examined check in a general way with the man-hour costs exhibited earlier. Railroad and waterway are in the middle of the scale (per ton-mile), with the waterway showing a small saving; the pipe line far down on the cost scale; the truck with the highest cost of all.

Turning to the concept of utility, it is possible to suggest from the point of view of physical costs the advantages and disadvantages of each agency. The railroad will retain for years to come its advantage as the backbone of the transport organism. For the line haul of bulk goods in other than liquid form, it is superior to the waterway because of its flexibility—rails go to 10 times as many places as waterways can go. The truck is superior to both in flexibility, and its field is the expeditious handling of local traffic on door-to-door delivery. It is also sometimes superior in the line haul when questions of time (perishable goods) or packages and crating costs are involved. The pipe line is the cheapest and most useful of all forms of transport for the limited kinds of goods it can handle.

The pipe line may have a significant future in handling more kinds of goods. The truck is destined to be supreme in local transport, and its function will grow as decentralization gains. The railroad, with lighter equipment and lower costs resulting from the elimination of competitive waste, and with improvement in operation which will reduce switching, terminal, and reclassification costs, will dominate the long haul, delivering to the truck at terminals outside city limits. The waterway will supplement the long hauls on those limited sections of the map where navigable routes obtain without exorbitant outlays for channel maintenance. The social necessity of developing flood control and power will tend to reduce waterway costs for navigation, in that the latter become a byproduct.

In the next few years the transport system may have to adjust itself to these changes and to such external conditions as the gathering decentralization movement, with disruption of accustomed traffic flows, and the equally certain and probably permanent decline in bulk exports, as economic nationalism gains both here and abroad. It thus becomes vitally important that physical necessities of moving the goods with maximum utility should take precedence over the preservation of corporate entities, to the end that anyone, or any combination of transport agencies, may be freely employed to move the traffic. Pending such studies in physical utility and physical costs, and the preparation of records in terms of the five factors we have described, it would be unfortunate to embark on a program of wholesale scrapping of any part of the transport plant, or of large extension of present facilities. The optimum rate of obsolescence and improvement, which not only transport but every modern industry must find, will never be discovered by employing the financial calculus alone.

SECTION III

III. CONSERVATION AND USE OF WATER ON FARMS IN HUMID AREAS

By R. E. Horton

1. Supplemental Irrigation

Individual storage and use of water on farms in humid climates may be for either of two principal purposes: (1) to provide water for stock, particularly during droughts; (2) and to provide water for irrigation to increase crop yields in periods of normal precipitation and to sustain crop yields in periods of subnormal rainfall. Individual farm storage of water is stressed for two reasons: (1) It is the simplest and most practical method of applying drought insurance as regards water supply for stock; (2) from the viewpoint of economics and conservation, it is the best method of providing water for irrigation to supplement rainfall.

Irrigation in humid climates differs so markedly from irrigation of arid lands that it may better be described as "supplemental irrigation."

Supplemental irrigation is almost universally an individual farm operation as distinguished from irrigation in arid lands, which is usually a community operation. Supplemental irrigation is invariably applied to land already under productive cultivation, whereas arid land irrigation is applied to land not naturally productive because of the aridity, and invariably brings additional land under cultivation.

2. The Need for Supplemental Irrigation

The use of irrigation to supplement rainfall in crop production in the humid portions of the United States has taken place to a limited extent since 1900 or earlier, and to a rapidly increasing extent since the eastern and southern drought of 1929 and 1930.

In order that supplemental irrigation may be economically feasible it must, in general, produce beneficial results in all years, wet or dry; otherwise the overhead expense on the investment during wet years may overbalance the profit in other years.

It is well known that for many farm crops there is a critical period—usually during the filling out of the fruit, seed, grain or tubers—when the crop must have adequate water; otherwise a failure will result. An optimum distribution of precipitation seldom occurs even in wet years. Therefore there is an economic use for supplemental irrigation in such years, as well as in relatively dry years.

A fairly definite relation exists between infiltration, or the rain absorbed by the soil, and the yield of crops. This is proven by various experiments on irrigated lands, where different quantities of water entering the soil are compared with crop yield. In general the relation between the water entering the soil and the crop yield is as shown in generalized form by figure 1.

The important point here is that a seasonal distribution of a certain amount of available water will give a maximum crop yield on a given soil and with a given crop. The limiting amount of water which increases the crop yield, or the amount which gives maximum yield, is usually much greater than the amount supplied by rainfall alone, even in the more humid States. For various reasons it is not usually economical to apply as much supplemental water to a crop as would be required to produce the maximum possible yield. In general it is desirable, if practical and economic conditions permit, to give a crop at least as much water each and every year as would be available from rainfall alone in the most favorable years—i. e., in years of greatest natural yield. The crop is naturally adapted to the use of at least this amount of water in productive activity.

The maximum quantity of water available for plant use from rainfall is that part which enters the soil as infiltration. A study of water loss data in conjunction with crop yields in years of different rainfall shows that in general an average of at least 18 inches of water is required for full crop production during the growing season in the humid States. The difference between this requirement and the available rainfall or infiltration represents the supplemental water required to provide for a full crop production.

Calculations have been made of the supplemental water required in each of the 3 years 1930, 1931 and 1932 at various stations in the United States.

The group of years 1930 to 1932 includes for each station, with some exceptions, a dry crop season, a crop season with nearly normal rainfall, and a crop season with better than normal rainfall.

Figure 2 shows the results of the computation of supplemental water required for 6 stations, 3 in the Atlantic coastal region and 3 in the somewhat less humid Central States and Mississippi Valley region. The unshaded areas are the amounts of supplemental water needed to bring the available supply up to a seasonal total of 18 inches.

Bearing in mind that the figures given are of necessity highly generalized and mainly illustrative, still there is no room for doubt that to maintain uniform and high productivity quantities of water ranging from minima of 6 to 12 inches are needed to supplement rainfall in humid regions in all or nearly all years, whether wet or dry. The application of these amounts of water will not give the maximum possible crop yields; they are the minimum amounts which will give in all years yields corresponding to the higher yields obtained in the same region from natural rainfall in the most favorable years.

3. Sources and Amount of Water Supply Available

The region herein referred to as the humid region, in which supplemental irrigation is more or less generally desirable and obtainable, includes the eastern portion of the United States extending westward to and including the eastern portions of the Dakotas, Nebraska, Kansas, Oklahoma, and Texas.

Nature has fixed a natural limit to the amount of water which may be utilized for supplemental irrigation in any given region. The water available for such use obviously cannot exceed the total run-off from the land, since all the remaining part of the rainfall is already transpired by plants or incidentally and unavoidably consumed as evaporation.

Since 6 to 12 inches of water is in general required for full crop yield with supplemental irrigation, the percentage of the farm area which may be irrigated depends upon the water supply available. In subhumid sections, where less than 2 or 3 inches of run-off occurs, supplemental irrigation is in general impracticable excepting where water can be taken directly from perennial streams flowing through the region.

Water for supplemental irrigation may be obtained in a variety of ways:

1. From the natural flow of perennial streams.
2. From storage of winter and spring run-off in headwater ponds on individual farms.
3. From the regulated flow of larger streams.
4. From natural lakes.
5. From large-capacity wells by direct pumping, as required for application to the land.
6. From medium-capacity wells by continuous pumping during the irrigation period, with storage of the water pumped during the part of the 24 hours when it is not being applied to the land.
7. From small-capacity wells by continuous pumping during the spring and summer season, the water being stored in individual farm ponds until needed, much as in the case where direct surface run-off is used.

4. Methods of Applying Supplemental Water

Individual irrigation is general in rice and cranberry culture. Exclusive of this there are many thousands of installations of supplemental irrigation using mainly: (1) Western methods, particularly the flooding and furrow methods; (2) spray irrigation, particularly for truck gardening and small fruits. Subsurface irrigation by porous tile has also been tried, but its use has not become common because of the high installation cost.

Within the past few years, winter irrigation of citrus orchards in Florida has been undertaken, the water usually being procured from a nearby lake and distributed by cheap types of portable piping laid on the ground or by a combination of piping and western methods. This practice has grown with great rapidity in the past 2 years.

During the drought period of 1929-30 the porous-hose method of water distribution was developed in Michigan and its use has increased rapidly. In potato irrigation, for instance, the field is usually given an application of 1 inch per week for 6 to 12 weeks, a total of 6 to 12 inches of supplemental water. Such irrigation is carried out regardless of rainfall.

While already applied to many crops, including potatoes, sugar beets, truck crops, berries, and small fruits, the porous-hose method is still in an early stage of development. Improvement in hose to secure higher rates and greater uniformity of distribution of water is evidently possible. In particular, the application of this method to tall-growing crops, such as corn and small grains, requires development of a simple, practical method of moving the hose line from one crop row to another.

While complete statistics are not available, it is estimated that there are more than 1,000 installations of this type in Michigan alone. A large but unknown number of such installations has been made during the severe drought of the past summer.

The porous-hose method has many advantages over other available methods of water distribution for supplemental irrigation:

1. The land does not require special preparation.
2. The land need not be perfectly level or uniformly sloping.
3. The installation cost for water distribution is small.
4. The method is extremely flexible.

Because of its economical and practical advantages and its proved success, it appears probable that the porous-hose method, modified and improved, either alone or in conjunction with other methods, will come into general use for supplemental irrigation in humid and subhumid regions. The remainder of this discussion is largely predicated on this assumption.

5. Increase in Crop Yield

Prof. O. E. Robey of Michigan State College, who has been active in the development of the porous-hose method, states that the usual increase in crop yield in Michigan as a result of supplemental irrigation during the past 4 or 5 years has ranged from 50 to 200 percent. Sometimes much greater increase in crop yield is obtained. The normal yield of potatoes without irrigation in Michigan is about 100 bushels per acre. In one case where porous hose irrigation was used during the past dry summer the potato crop just harvested at the date of this writing yielded 435 bushels per acre. Hose used in this method of application is shown in the accompanying illustration.

Potatoes are peculiarly well adapted to supplemental irrigation. The question naturally arises as to what increase in crop yield could be obtained in the humid region by this method in the case of other crops, such as corn and small grains.

Calculations have been made, based on crop yields reported by the United States Department of Agriculture for the years 1909 to 1924, inclusive, to show what percentage increase in crop yield would result from the application of supplemental irrigation in sufficient amount to bring the crop yield in all years up to the average of the three highest years. The yield in average and better than average years would then be considerably above the present maximum yields.

From data available as to the relation between water use and crop yield for various crops, it appears certain that the application of an average of, say, 9 inches of supplemental irrigation water would produce an increase of crop yields ranging from 40 percent to 100 percent or more for most general farm crops, the higher figures applying to special crops such as potatoes and sugar beets.

6. Legal and Economic Aspects

Direct abstraction of any part of the normal flow of perennial streams, even for use by a farmer on his own land, will in general incur legal liability for diversion under existing water laws in the humid States. Furthermore, widespread diversion, either from streams, lakes, or ground water, reduces the natural summer flow of streams and in general impairs the economic value of the streams for other uses. Conflict with other economic uses can be avoided by restoring the natural flow by storage regulation. This would also in general satisfy legal requirements.

With such regulation the water used for supplemental irrigation would not actually be derived directly from stored water in the larger streams, but would be derived from water abstracted from tributary streams, surface run-off, or ground water, and the water so abstracted would be replaced in the main streams by impounded flood waters.

The use of individual farm storage ponds, constructed where economical and practicable in draws or near the heads of small

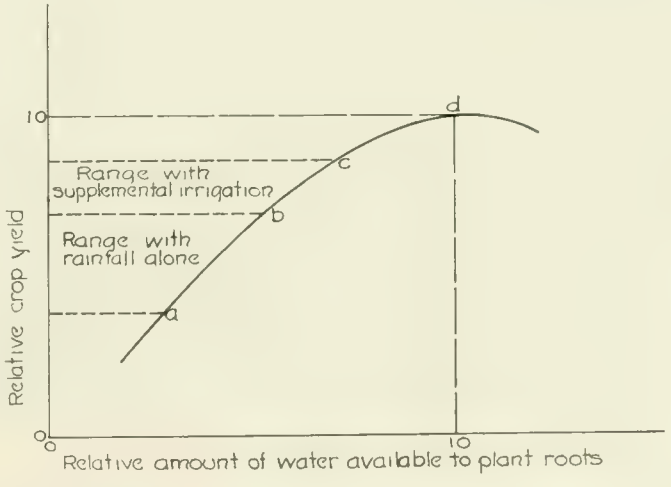


FIG. 1 - GENERALIZED DIAGRAM ILLUSTRATING THE RELATION OF THE AMOUNT OF AVAILABLE SOIL MOISTURE TO CROP YIELD

tributary streams, to impound surface run-off during the winter and spring for use when needed, does not involve legal difficulties; neither does it conflict in any important degree with other economic use of water resources. This is conservation of the highest type, since it not only serves a useful purpose but utilizes water which would otherwise generally be wasted, and which, if wasted, may produce detrimental effects through soil erosion and contribution to floods. Large dams or those impounding large volumes of water should be constructed with adequate technical supervision.

In this connection it should be noted that terracing of land to prevent soil erosion has the effect of holding back the rainfall until it can be absorbed by the soil, thus increasing the ground-water supply.

7. Future Possibilities

Supplemental irrigation properly applied may have three direct beneficial effects:

1. Crop insurance, or elimination of crop failures due either to droughts or to unfavorable distribution of rainfall during critical periods of crop growth.
2. Stabilization of crop yields, with a consequent tendency to stabilization of food prices.
3. Increase of the productivity of land already under cultivation and hence increase of the average level of crop yield.

Supplemental irrigation also improves the grade and quality of such farm crops as potatoes, particularly in dry years.

In a given locality the ultimate possible extent to which supplemental irrigation can be applied depends mainly on three factors: (1) the existence of an adequate water supply; (2) the practicability of using the water when and where needed; (3) the character and economic value of the crops grown, as determined by soil, climate, and market conditions.

Taking these three main factors into account, an estimate has been made of the percentage of farm area to which supplementary irrigation could be applied in each State. These percentages have been applied to the acreage of farm lands in the different States, as given by the 1930 census. On the basis of these figures, out of a total of 769,000,000 acres in farm lands in the humid region, supplemental irrigation is capable of application, probably within limits of economic feasibility within the next few decades, to roundly 134,000,000 acres, or about 17 percent of the farm area, and to something like 2,500,000 farms.

FIGURE 3.—A view of the type of perforated hose used for supplementary irrigation of potatoes in the Michigan area.

Care has been taken in making these estimates to keep within reasonable limits as to the portion of the total available water supply used for this purpose, in such a manner as to avoid undue conflict with or reduction in the available water supply required for other economic uses. The total available water supply is determined by the total land area; and the depth of water expressed in inches on the total land area, which would be required to carry out the supplemental irrigation program above outlined is 1.1 inches. This would provide an annual depth of supplemental irrigation of 9 inches on the entire area irrigated, which would consume about 20 percent of the total available water supply in the subhumid section, and 4 to 8 percent in the humid section.[1]

In planning future use of water resources a reservation should be made of the equivalent of at least 1 inch of water on the land area in the humid region for supplemental irrigation when needed. In the meantime this water may be applied to other purposes.

8. Supplemental Irrigation and Rural Electrification

From experience in Michigan the cost of porous-hose irrigation, including all items, is from $1.75 to $2.75 per acre-inch. The cost is divided about equally between labor, overhead and maintenance, and energy cost. (See Fig. 3.)

The cost of energy in Michigan—mainly fuel and oil for engines—ranges generally from $0.50 to $1 per acre-inch, or $6 to $12 per acre-year, irrigated to 12 inches depth. The lower cost applies to the most efficient, direct-connected pumping units, with low pumping heads.

Based on Michigan experience, with pumping units of average efficiency, Prof. O. E. Robey [2] gives the cost of gasoline and oil, with gasoline at $0.12 per gallon, as $0.54 per acre-inch, with a total head of 100 feet. Lower costs are attained with the most efficient internal-combustion engine units using mainly fuel oil.

With a motor-driven unit the cost of energy per acre-inch would be:

$0.227 with electricity at 1¢ per kilowatt-hour.
$0.45 with electricity at 2¢ per kilowatt-hour.
$0.68 with electricity at 3¢ per kilowatt-hour.

It is evident that with day energy costing more than 2 to 2½ cents per kilowatt-hour, electric pumping cannot compete in energy cost with engine-driven units. Pumping is, however, a remarkably steady and desirable load, especially when there are numerous installations in the same locality, and should command a low price.

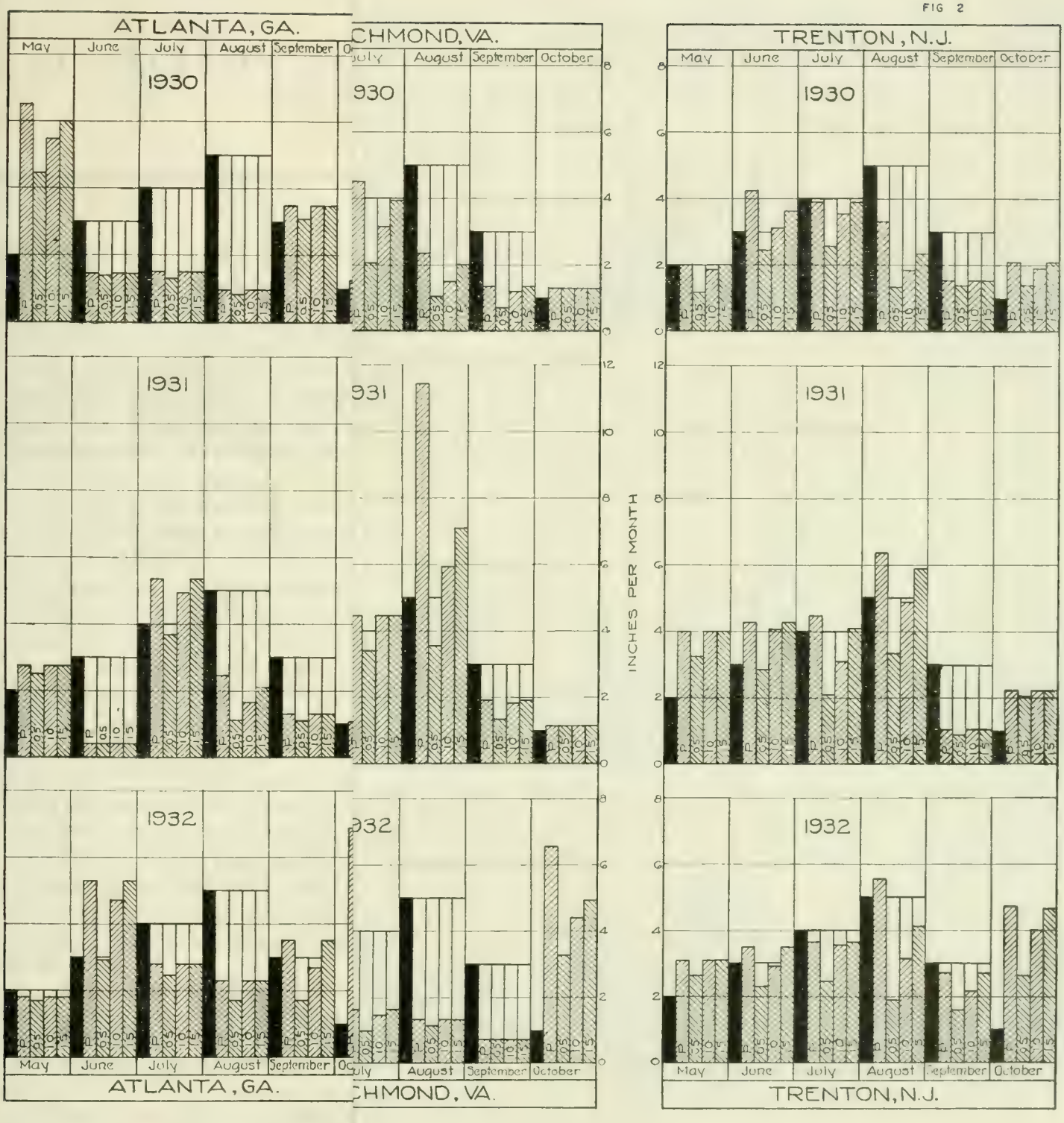
Application of water at night instead of in the daytime affords a promising line of development. Using a floodlight, practical operations can apparently be carried out without difficulty. Provided attractively low rates for off-peak power are obtainable, night operation should materially reduce the energy cost.

There are other advantages of the night application of water; there would then be no danger of scalding of plants, and there would be possible higher pressures, with consequent spraying of the water from the hose and application to the ground at much greater rates than now available. With a wide-spread extension of supplemental irrigation, the use of off-peak electric energy for pumping, if generally adopted, would provide a market for a considerable block of off-peak energy otherwise not easily disposed of. For illustration, if this method of pumping were applied to one-half the area needing and susceptible of supplemental irrigation in the humid States, or 67,000,000 acres, a total of 7,500,000,000 kilowatt-hours of off-peak energy would be utilized, equivalent to 16,000,000 horsepower, 8 hours per day for 75 days per year.

[1] Land in farms is about 70 percent of total area and an average of 17 percent of the farm area would be irrigated, or 12 percent of the total area. A depth of 9 inches on 12 percent of the area is equivalent to 1.1 inches on entire area.

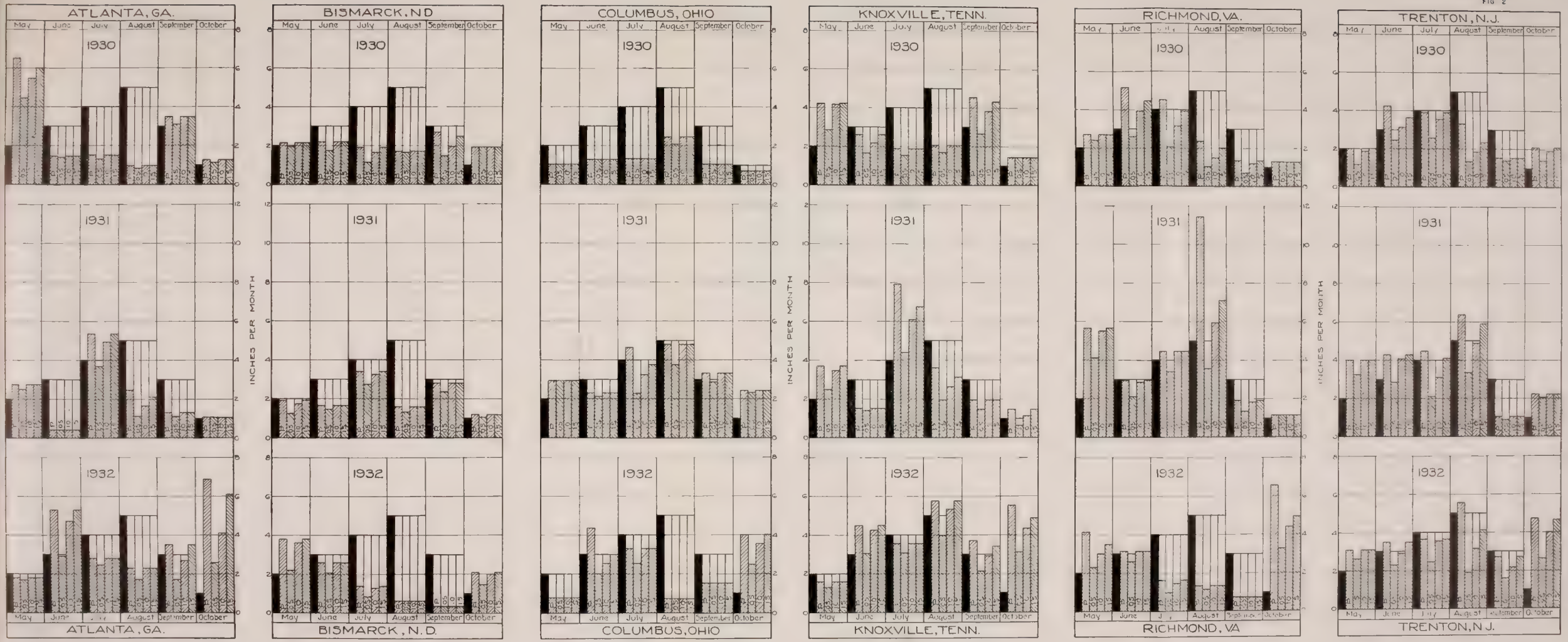
[2] Porous Hose Irrigation; Michigan State College Extension Bulletin 133; 1934.

FIG 2



R CROP USE,
MAY-OCT. INCLR DAY, RESPECTIVELY.

FIG 2



SUPPLEMENTAL WATER REQUIRED TO PROVIDE 18 INCHES TOTAL WATER FOR CROP USE, MAY-OCT. INCL., ON SOILS HAVING INFILTRATION CAPACITIES OF 0.5 INCH, 1.0 INCH AND 1.5 INCHES PER DAY, RESPECTIVELY.

~ LEGEND ~

- Unshaded areas show supplemental water required
- Water required - inches per month
- P Actual rainfall
- .05 Available water for soil having infiltration capacity of .05 inch per day
- 1.0 Do 1 inch per day
- 1.5 Do 1.5 inches per day

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SECTION III

IV. LEGISLATIVE ASPECTS OF THE USE AND CONTROL OF WATER RESOURCES[1]

By H. D. Padgett

I. Introduction

A comprehensive plan for the utilization and conservation of water resources will be affected profoundly by the status of water rights, intrastate and interstate, and by the legal and constitutional provisions relating thereto. While these matters have been considered in some detail, reports as indicated in the footnote having been prepared on various phases of the problems involved, the scope of this review does not permit the inclusion of a full discussion of these questions. There are presented here only some of the more important legal factors involved in the present use and control of water resources, and in any extension of Federal control.

The States in general claim and exercise control over the appropriation and use of waters within their respective boundaries, while the Federal Government is exercising a steadily increasing authority over the waters of the country by congressional action based upon its Constitutional power to control navigable waters. Naturally, the doctrines or principles governing the use of water vary in different sections of the country, as do the problems involved. In the arid States of the West, where the principal use of water is for irrigation, the doctrine of "prior appropriation" governs, while in the humid States, where navigation, public water supply, and power have been primary concerns, the doctrine of "riparian rights" is recognized. The trend of recent decisions by the Supreme Court of the United States indicates a tendency to modify these doctrines to permit a more "equitable apportionment" of the use of water.

The use of the water of interstate streams and the settlement of resulting controversies between States constitutes at present one of the more urgent problems. A conflict of interests, inevitably arises sooner or later on nearly every interstate stream, and no effective means for the settlement of such controversies has yet been devised other than resort to the United States Supreme Court. This fact becomes highly significant when it is realized that no general, comprehensive plan for the use and control of water can be effective or satisfactory without cooperation between the States.

II. Doctrines Governing Use of Water

(*a*) The riparian doctrine of the common law of England was adopted by this country at an early date and always has been the controlling principle of law in the use of water in the humid States east of the Mississippi River. Under this doctrine, each riparian proprietor is entitled to have the stream come to his land as it would naturally flow undiminished in quantity and unimpaired in quality. All riparian owners have an equal right to make reasonable use of the stream, which right does not mean, however, that all of them are entitled to equal amounts of water. This doctrine worked no particular hardship so long as the competitive demand for water was relatively low in relation to the available supply. As the demands for water increased, however, a rule so absolute and inflexible became in larger and larger measure impossible of strict application. Force of circumstances compelled a modification, if not an abandonment of the strict riparian doctrine. Two recent decisions of the Supreme Court of the United States lay down a principle of "equitable apportionment of the use" of interstate waters, based on the "equality of right" existing between States.

The case of *Connecticut* v. *Massachusetts* (282 U. S. 660, 1931) concerned a proposed diversion from the drainage area of the Connecticut River to provide water for Boston and vicinity. Connecticut set up its right under the riparian doctrine, which both States recognize, to the undiminished flow of the river, and alleged that to take water entirely out of the Connecticut Basin would impair the navigability of the Connecticut, increase dangers from pollution, and take away flood rights. The court, in rendering its opinion, clearly indicated abandonment of the riparian doctrine as applied to interstate questions, and laid down another principle by saying:

"But the laws in respect of riparian rights that happen to be effective for the time being in both States do not necessarily constitute a dependable guide or just basis for the decision of controversies such as that here presented.

"Such disputes are to be settled on the basis of equality of right. But this is not to say that there must be an equal division of the waters of an interstate stream among the States through which it flows. It means that the principles of right and equity shall be applied having regard to the 'equal level or plane on which all the States stand, in point of power and right, under our constitutional system,' and that, upon a consideration of the pertinent laws of the contending States and all other relevant facts, this court will determine what is an equitable apportionment of the use of such waters."

The case of *New Jersey* v. *New York* (283 U. S. 336, 1931) concerning the Delaware River involved a set of facts similar to those in *Connecticut* v. *Massachusetts*, and the court in its decision again applied the doctrine of equitable apportionment, stating "the effort is always to secure an equitable apportionment without quibbling over formulas", and also, "The removal of water to a different watershed obviously must be allowed at times unless States are to be deprived of the most beneficial use on formal grounds."

(*b*) Under the "appropriation doctrine", the individual or group that first makes a beneficial use of water thereby acquires a prior right to its continued use. Practically all of the States of the arid and semiarid West have adopted this doctrine. Strange to say, it originated and was developed in California, which always has recognized the riparian doctrine or a modified form thereof. This resulted from the necessities of the situation in the

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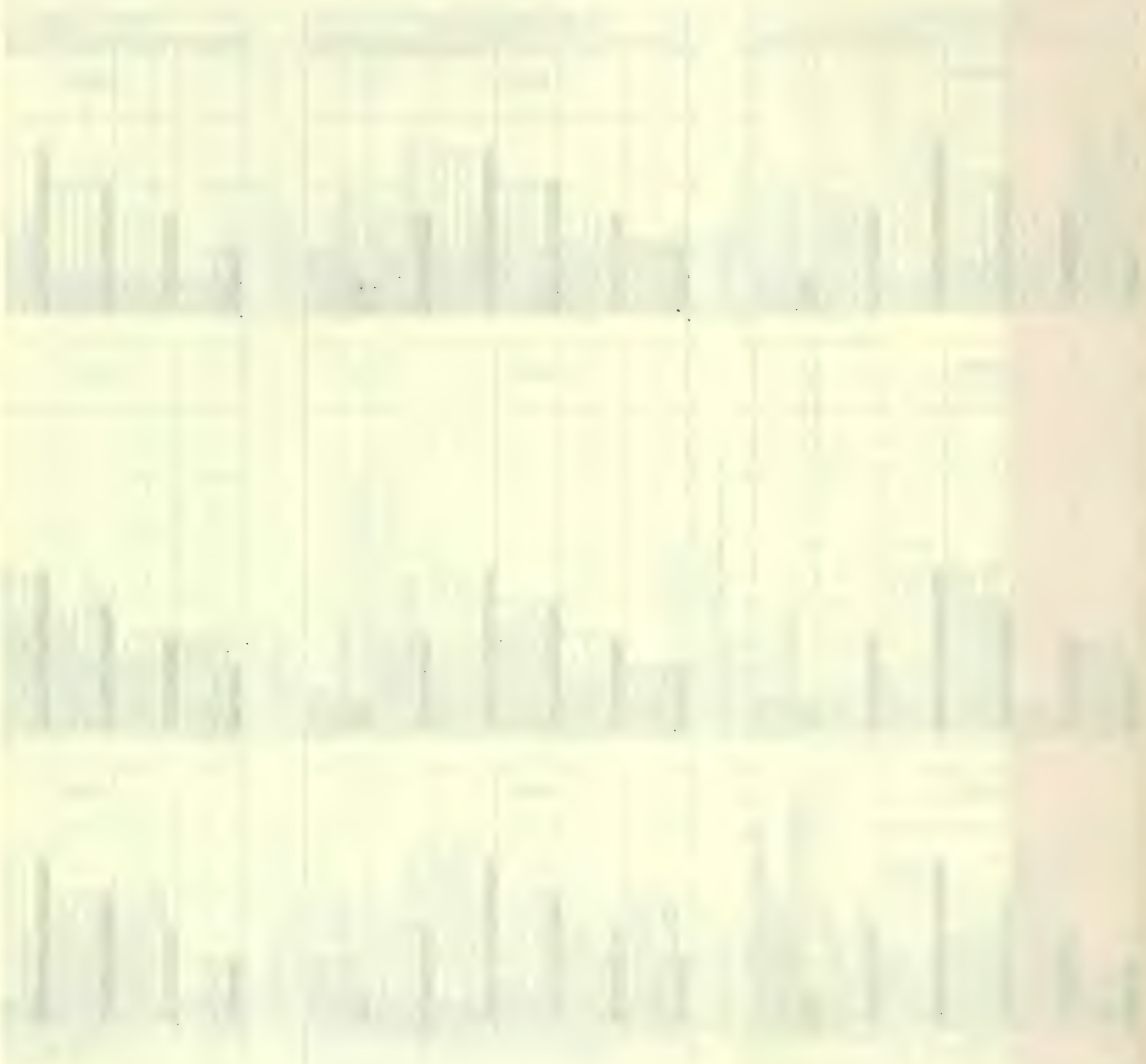

SECTION III

IV. LEGISLATIVE ASPECTS OF THE USE AND CONTROL OF WATER RESOURCES[1]

By H. D. Padgett

I. Introduction

A comprehensive plan for the utilization and conservation of water resources will be affected profoundly by the status of water rights, intrastate and interstate, and by the legal and constitutional provisions relating thereto. While these matters have been considered in some detail, reports as indicated in the footnote having been prepared on various phases of the problems involved, the scope of this review does not permit the inclusion of a full discussion of these questions. There are presented here only some of the more important legal factors involved in the present use and control of water resources, and in any extension of Federal control.

The States in general claim and exercise control over the appropriation and use of waters within their respective boundaries, while the Federal Government is exercising a steadily increasing authority over the waters of the country by congressional action based upon its Constitutional power to control navigable waters. Naturally, the doctrines or principles governing the use of water vary in different sections of the country, as do the problems involved. In the arid States of the West, where the principal use of water is for irrigation, the doctrine of "prior appropriation" governs, while in the humid States, where navigation, public water supply, and power have been primary concerns, the doctrine of "riparian rights" is recognized. The trend of recent decisions by the Supreme Court of the United States indicates a tendency to modify these doctrines to permit a more "equitable apportionment" of the use of water.

The use of the water of interstate streams and the settlement of resulting controversies between States constitutes at present one of the more urgent problems. A conflict of interests, inevitably arises sooner or later on nearly every interstate stream, and no effective means for the settlement of such controversies has yet been devised other than resort to the United States Supreme Court. This fact becomes highly significant when it is realized that no general, comprehensive plan for the use and control of water can be effective or satisfactory without cooperation between the States.

II. Doctrines Governing Use of Water

(*a*) The riparian doctrine of the common law of England was adopted by this country at an early date and always has been the controlling principle of law in the use of water in the humid States east of the Mississippi River. Under this doctrine, each riparian proprietor is entitled to have the stream come to his land as it would naturally flow undiminished in quantity and unimpaired in quality. All riparian owners have an equal right to make reasonable use of the stream, which right does not mean, however, that all of them are entitled to equal amounts of water. This doctrine worked no particular hardship so long as the competitive demand for water was relatively low in relation to the available supply. As the demands for water increased, however, a rule so absolute and inflexible became in larger and larger measure impossible of strict application. Force of circumstances compelled a modification, if not an abandonment of the strict riparian doctrine. Two recent decisions of the Supreme Court of the United States lay down a principle of "equitable apportionment of the use" of interstate waters, based on the "equality of right" existing between States.

The case of *Connecticut* v. *Massachusetts* (282 U. S. 660, 1931) concerned a proposed diversion from the drainage area of the Connecticut River to provide water for Boston and vicinity. Connecticut set up its right under the riparian doctrine, which both States recognize, to the undiminished flow of the river, and alleged that to take water entirely out of the Connecticut Basin would impair the navigability of the Connecticut, increase dangers from pollution, and take away flood rights. The court, in rendering its opinion, clearly indicated abandonment of the riparian doctrine as applied to interstate questions, and laid down another principle by saying:

"But the laws in respect of riparian rights that happen to be effective for the time being in both States do not necessarily constitute a dependable guide or just basis for the decision of controversies such as that here presented.

"Such disputes are to be settled on the basis of equality of right. But this is not to say that there must be an equal division of the waters of an interstate stream among the States through which it flows. It means that the principles of right and equity shall be applied having regard to the 'equal level or plane on which all the States stand, in point of power and right, under our constitutional system,' and that, upon a consideration of the pertinent laws of the contending States and all other relevant facts, this court will determine what is an equitable apportionment of the use of such waters."

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old gold-mining days, when the rapid development of placer mining created a demand for all available water. The community worked out a system of "first come, first served", the right acquired dating from the time work was initiated. These activities all took place on public lands and Congress recognized the local laws and customs, and thereby the doctrine of appropriation, by an act of 1866 (14 Stat. 253), and it confirmed this policy by subsequent legislation (act of July 9, 1870, 16 Stat. 217). This doctrine appears to be firmly established, not only as a result of the legislation to which reference has been made but also in view of decisions of courts in the various States and of the United States Supreme Court.

There have been two notable interstate cases involving this doctrine, and while the decisions were rendered years ago (1907 and 1922), they constitute the only settled law on such interstate questions in the arid West. In the case of *Kansas* v. *Colorado* (185 U. S. 208; 206 U. S. 46; 1901, 1907), the dispute involved the use of the water of the Arkansas River, which rises in Colorado and flows into Kansas. Kansas alleged that the depletion of the flow of the river by the irrigation of a large acreage in Colorado had injured its lands and citizens. Recognizing the riparian doctrine, Kansas claimed a right to the entire flow of the river. Colorado, where the appropriation doctrine had been adopted, claimed the right to use all the waters originating within its borders on the basis of its sovereign right of ownership in said waters. The court decided, notwithstanding the fact that Kansas had suffered some damage from the depleted flow of the river, and in view of the great benefits derived by Colorado, that "it would seem that equality of right and equity between the two States forbids any interference with the present" use of water in Colorado; also that further depletion of the water by Colorado might result in a situation where "Kansas may justly say there is no longer an equitable division of benefits and may rightfully call for relief."

The decision in this case has been interpreted by many as establishing a principle of "equitable division", or "equitable apportionment", of the waters of a stream, but in the opinion of James Grafton Rogers, noted member of the Denver bar, it does not announce any such principle, but rather "it does say there must be an equitable limit to conflicting sovereignties, a fair adjustment of their otherwise complete and entire right of assertion, and an apportionment not of water but of natural benefits."

The case of *Wyoming* v. *Colorado* (259 U. S. 419, 496; 260 U. S. 1, 1922) involved the use of the waters of the Laramie River, which rises in Colorado and flows thence into Wyoming. Wyoming alleged that a proposed diversion in Colorado of water from the Laramie Basin to lands outside the basin in that State would injure prior appropriations in Wyoming. Both Wyoming and Colorado recognize the doctrine of prior appropriation, but Colorado claimed the right to use all the waters within her borders by reason of her sovereignty or statehood. On the other hand, Wyoming contended that priority, regardless of State lines, should apply, and therefore that she, having prior appropriations of sufficient volume, was entitled to the entire flow of the stream. The court held that the prior appropriation doctrine, recognized by both States, was applicable to interstate streams and controversies, and furnished "the only basis which is consonant with the principles of right and equity applicable to such a controversy as this." But it also reaffirmed the Kansas-Colorado decision on the basis of the difference in the doctrines in the two States. The court by decree fixed the amount of water which Colorado might divert, basing it on the quantity remaining after deducting from the aggregate supply the total of prior appropriations in Wyoming. Many who have studied the question hold the opinion that the doctrine of prior appropriation as between States is inequitable, penalizing the State which is unable to develop its resources as rapidly as another, or finds it unnecessary to do so. While this doctrine was prompted by necessity and was suitable for the conditions under which it was developed, it is not a satisfactory principle under which to govern the use of interstate waters, especially under any comprehensive plan considering future needs as well as present needs.

If the more recent decisions of the Supreme Court, referred to above, in which the riparian doctrine was disregarded and a rule of "equitable apportionment" of the use of water was laid down, may be considered as a criterion, it apparently may be assumed that in a proper case the court will likewise abandon or modify the "appropriation doctrine" as applied to interstate questions.

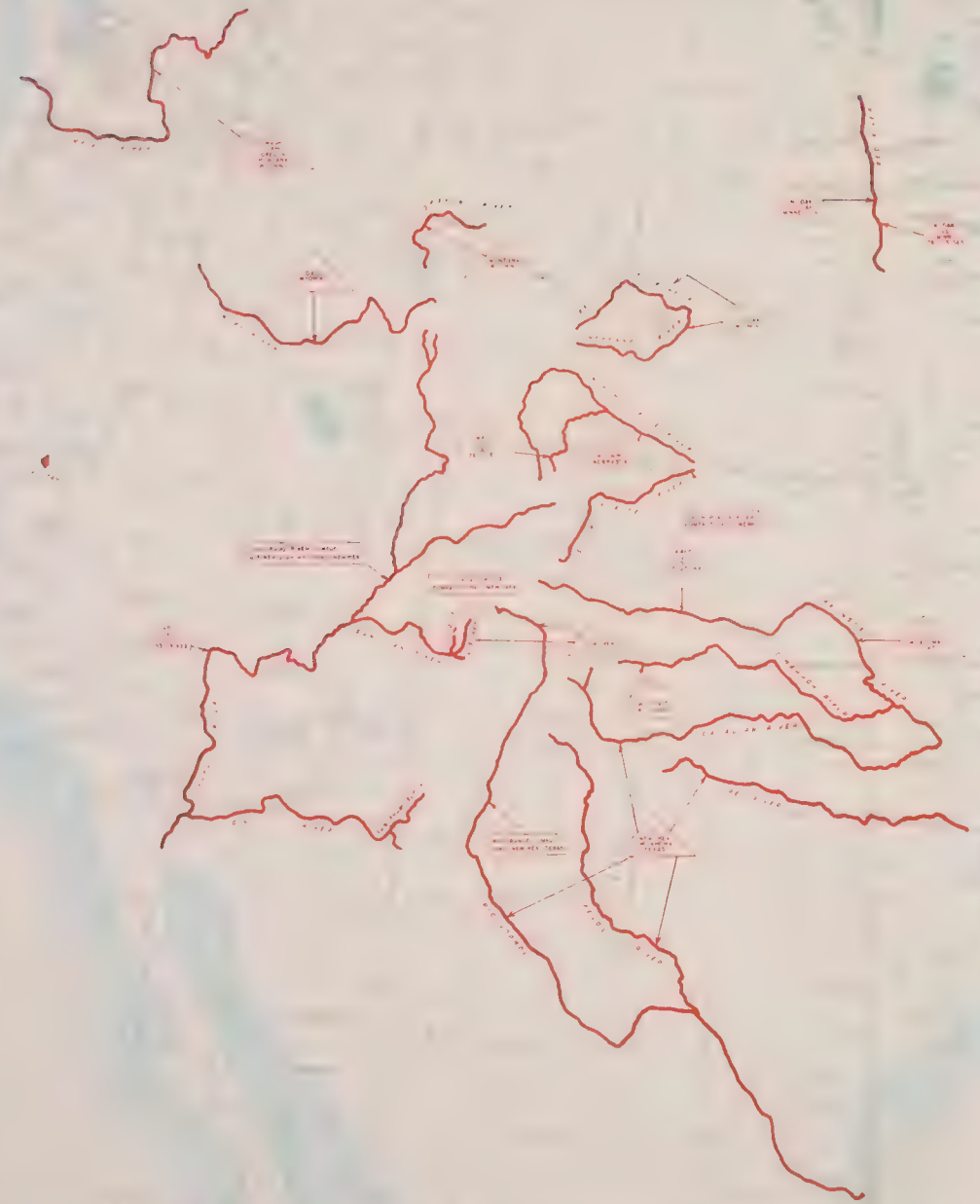
III. Federal Control Over Water Resources

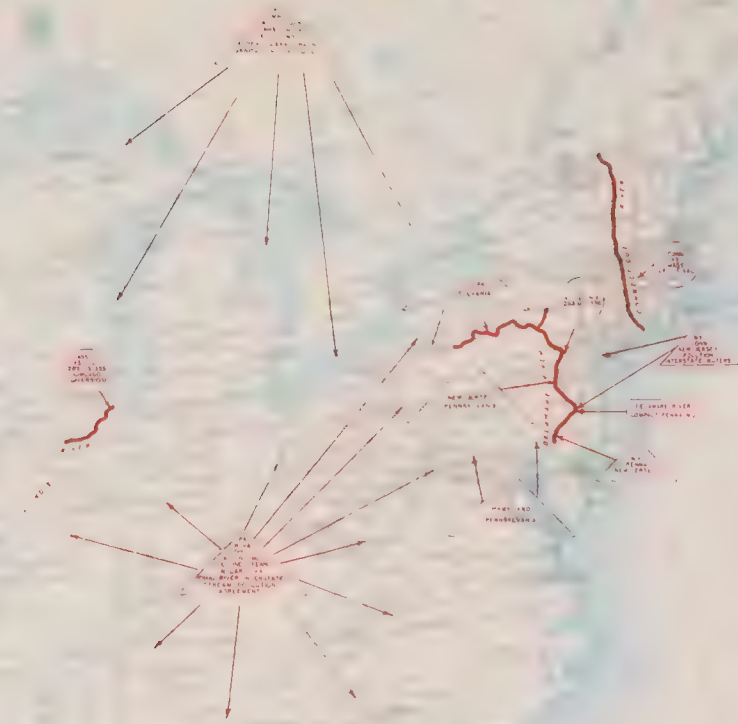
The basis of the control now exercised by the Federal Government over the waters of the country rests primarily upon the power of Congress with respect to navigable waters. Congress has also exercised jurisdiction control in connection with flood control, the public lands, treaty obligations, and interstate compacts.

(*a*) Congress has control over all navigable waters of the country. This power is not granted expressly by the Constitution but is incidental to and based solely on its power to "regulate commerce with foreign countries and among the several States" (art. 1, sec. 8, clause 3 of the Constitution). The power of Congress over navigable waters has been exercised from the outset and has been upheld by repeated decisions of the Supreme Court.

(*b*) Federal control of water power is based primarily on the power of the Government to control navigable waters, but in certain instances also results from the use of public lands and reservations. The acts of March 3, 1899 (30 Stat. 1151) and June 23, 1910 (36 Stat. 593) prohibited the construction of dams in navigable waters, except upon affirmative authorization by Congress. The numerous requests for special permission to construct dams for power purposes and the work involved in determining whether or not the interests of the United States would be affected adversely by the proposed constructions, led to the creation of the Federal Power Commission (act of June 10, 1920, 41 Stat. 1077) to relieve Congress of this burden and to afford a more general determination of policy in such matters. The act is the culmination of a steadily increasing exertion of Federal authority over navigable waters by legislative construction of the Constitutional power. Under this act, control has been extended over nonnavigable streams which affect the navigable capacity of navigable streams. Perhaps a greater degree of control is exercised over some phases of the development and use of power than strictly is required for navigation purposes. The lower courts have upheld the act, however, on the ground that its principal purpose is the protection of navigation. The Supreme Court has not had occasion to pass on the constitutionality of the act.

(*c*) Flood-control projects of the Federal Government usually have involved the protection or promotion of navigation, which affords unquestionable constitutional authority for this work. The Federal Government doubtless also has power to build flood-control projects to protect interstate commerce over highways and railroads, the Postal Service, and the lives and safety of its citizens. An act of March 1, 1917 (39 Stat. 950), authorized examinations, surveys, and reports on flood-control projects generally, and the carrying out of flood-control development work on the Mississippi and Sacramento Rivers. Under the act of Jan. 21, 1927 (44 Stat. 1010), as set forth in H. Doc. 308, Sixty-ninth Congress, first session, the War Department has





NATIONAL RESOURCES BOARD

WATER RESOURCES SECTION

LOCATION OF THE MORE IMPORTANT INTERSTATE WATER PROBLEMS

LEGEND

- Streams and Lakes with Interstate Water Problems shown in Red
- Suits between States. Supreme Court Decisions
- Compacts in effect
- Proposed compacts
- Informal agreement between State Sanitary Boards or Health Departments (stream pollution)

thus far made about 185 reports (the "308 reports") covering investigations and surveys on many of the principal streams of the country with respect to navigation, flood-control, water power, and related factors.

(*d*) The Federal Government has been able, through its authority in the matter of rights-of-way over public lands, to exercise considerable control over the use of water in the public-land States, especially where its interests, due to reclamation or other projects, were involved. Public lands are the basis of the Reclamation Act (32 Stat. 388) under which the Bureau of Reclamation operates. This Bureau has exercised indirectly a certain degree of control over the development of the streams on which its projects are located.

(*e*) A question long debated and yet undecided by the Supreme Court concerns the ownership of the unappropriated waters in the public land States of the West. One theory, known as the "California doctrine", holds that when the Federal Government originally acquired this territory it became not only the owner of the lands but also the owner in a strict and proprietary sense of the right to use the waters of these lands; and further that conferment of statehood passed political powers, not property rights. The leading case advancing this theory is *Lux* v. *Haggin* (69 Calif. 255, 1886). Under the opposing theory, generally known as the Colorado doctrine, the Federal proprietary title to water is denied, and all rights to water are held to rest upon State sovereignty and State law.

While the Federal Government has on numerous occasions asserted its claim to ownership of these waters, notably in *Wyoming* v. *Colorado*, Congress at the same time has evidenced an intent to avoid conflict with State control of such waters, notably by provisions in the Reclamation Act and acts supplementary thereto. If the ownership of these unappropriated waters is in the United States, then there is a property-right, as in the public lands, which belongs to the Nation, and which should be disposed of only by the Federal Government and then only in accordance with some appropriate plan or policy. Steps should be taken to secure a decision by the Supreme Court on this question. A decision one way or the other would aid greatly in arriving at a plan for the development of the waters of the Western States.

(*f*) The Federal Government has unquestioned control over the waters of Indian lands and reservations, and may reserve them from appropriation or use by others. Obligations assumed by the United States under treaties regarding international streams sometimes require the Federal Government to exercise a certain degree of control over such streams.

Interstate compacts require the approval of Congress, which may impose with respect to them any conditions it may consider necessary or desirable. Congress might use this means of exercising control, in some instances, over interstate streams. Little has been accomplished in this direction, however, by the four interstate compacts now effective.

IV. State Control

It is the theory and contention of the States of the arid region that control of the waters within their boundaries lies exclusively with them, and most of them, either by constitutional provision of by legislative enactment, have declared that such waters are the property of the State or of the public. State sovereignty forms the basis of the State laws and codes governing the appropriation and use of water. Most of these States have codes providing a complete system by which rights to water may be acquired or adjudicated, and the use of water administered, that result in rather complete control over their water resources. In the States east of the Mississippi River there has never been any question as to the power of the State to control the waters within its boundaries, there being little public land and no Federal interests except in connection with navigation or of diversions from one drainage basin to another. The extent of State control varies from practically no control in some of the southern States to complete control over all water uses and developments in the State of New York.

V. Interstate Controversies

The primary causes of interstate controversies relating to streams lie in the increasing competition for water and in the lack of a reasonably planned program. When the supply of water is abundant in relation to its use or the demand for it, any system of water-taking, no matter how illogically developed, tends to avoid controversy. When competitive groups or localities become jealous in the defense of present of future needs, then controversy inevitably arises. These competitive struggles are the results of having no central or regional agency authorized and equipped to consider these problems.

Practically all the mechanisms available for the intelligent development of stream resources are handicapped to some extent by the constitutional sovereignty of the States. With a number of independent governmental agencies struggling to control and utilize resources available to several States but not owned by any of them, progress has been difficult, in spite of a long series of legal decisions. These difficulties are likely to continue until some comprehensive plan involving administrative control is substituted for intermittent court decisions on specific issues.

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Practically all the mechanisms available for the intelligent development of stream resources are handicapped to some extent by the constitutional sovereignty of the States. With a number of independent governmental agencies struggling to control and utilize resources available to several States but not owned by any of them, progress has been difficult, in spite of a long series of legal decisions. These difficulties are likely to continue until some comprehensive plan involving administrative control is substituted for intermittent court decisions on specific issues.

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2. Suits between private parties in different States concerning water rights on interstate streams merely settle individual controversies and afford little, if any, aid in the solution of the larger interstate problems. In fact, the settlement of interstate controversies over water rights in suits where the States concerned are not before the Court frequently complicates the situation.

3. Some of the means resorted to in the attempt to adjust or settle interstate problems, aside from recourse to the Courts, have been as follows: Voluntary, informal interstate agreements have been useful in handling some problems. A notable example is the Ohio River Interstate Stream Conservation Agreement, entered into in 1924 between the Health Departments of Ohio, Pennsylvania, and West Virginia, and subsequently by eight other interested States, for the purpose of conserving interstate streams and preventing the undue pollution of them. The cooperative activities of the States under this agreement still continue. Such agreements afford some opportunity for planning, but they cannot have, because of their quasi-legal character, any power of apportionment of waters or of enforcement of plans.

Fusion of special State administrative agencies by concurrent legislation of the States has been employed as a means of settling interstate problems. The New York and New Jersey Port Authority thus created has powers of planning and financing important undertakings.

Federal grants-in-aid to local areas have been instrumental in stimulating uniform State administration. It has been applied particularly to highway construction with considerable success. Properly applied, it may do much to stimulate interstate action toward water planning.

4. Interstate compacts are at the moment one of the few means available of attempting the settlement of interstate water problems, but their effectiveness has yet to be demonstrated. Such compacts are permissible under the constitution, and must be authorized and approved by Congress and also by the legislatures of the States concerned. Congress may impose any conditions it deems necessary, and in each case of a compact involving Western States it provided that a representative of the United States be appointed to participate in the negotiations. Four important compacts in settlement of interstate water rights are in operation, and all of them involve arid States.

Under the South Platte River compact between Colorado and Nebraska, effective since 1926, a satisfactory administration of the waters of this stream has resulted. In contrast, the status of water rights on the streams covered by the other compacts is uncertain.

The LaPlata River compact between Colorado and New Mexico, effective since 1925, provided for an apportionment of the use of water between these two States by means of rotation. However, the right of the water officials of Colorado to carry out the plan of rotation permitted by the compact at times of low flow was challenged by holders of some of the older rights in Colorado. The Colorado Supreme Court, on appeal, upheld the complainants (*LaPlata River and Cherry Creek Ditch Co.* v. *Hinderlider*, 25 Pac. 2d 187) and on further appeal, the United States Supreme Court dismissed the case for lack of jurisdiction. The comment of the Colorado court on the compact is of interest:

"* * * There is not the slightest pretense, either in this compact itself or in the proceedings leading up to it, to a decision of the question of what water Colorado owns, or what water New Mexico owns, or what their respective citizens own. It is a mere compromise of presumably conflicting claims, a trading therein, in which the property of citizens is bartered, without notice or hearing, and with no regard to vested rights."

The outcome of this case casts a cloud on this manner of settling interstate water disputes. The Colorado River compact, between six States of the Colorado River Basin, attempts to effect an apportionment of the waters of the river between the upper and lower basins. However, there still must be an apportionment of water between the States of the upper basin and likewise in the lower basin, and it remains to be seen whether this can be effected in view of the conflicting claims and interests of the various States. Here might be an opportunity for Congress to impose, as a condition to any further compacts, the requirement that some comprehensive plan for the development of the entire basin be worked out and adopted by the States as the basis for any apportionment of the use of the waters.

It is difficult to see how interstate water problems can be solved satisfactorily by compacts as now negotiated. Such compacts frequently are drafted in the turmoil of the competitive arena and sometimes without all the pertinent technical and social facts at hand. They are often the result of outright compromise and thus rest upon bargaining power rather than upon the reasoned application of fact.

Furthermore there is usually great delay in negotiating interstate compacts due to the conflict of interests, which nearly always hampers and may effectively prevent the best development and use of the stream as a whole. Thus, in the case of New Jersey and New York referred to above, commissioners for the States of New Jersey, New York, and Pennsylvania prepared a draft of an interstate compact covering the use of the waters of the Delaware River, which was unanimously acceptable to the commissioners, after 3 years of controversy, it being impossible to obtain the assent of the legislatures of all of the States, a suit in the Supreme Court was taken as the only solution. A similar situation has existed for the past 3 years between New York, New Jersey, and Connecticut relative to formulation of an interstate compact covering pollution of boundary waters.

VI. Conclusion

Interstate water problems exist on almost every interstate stream, and they are becoming more complicated and more difficult of solution as the demand for water increases. The Supreme Court is the only body with power to make a final settlement of controversies between the States. Nevertheless, this Court has decided only 5 interstate water cases; 2 involved irrigation in arid States, 1 involved drainage in the Middle West, and 2 involved municipal water supply in the North Atlantic States, these being the only recent cases (1931).

Furthermore, the Supreme Court, in recent decisions involving interstate waters, has left the way open for the interested parties to apply to the Court for modification or alteration of its decrees as new factors may arise. In effect this appears to make of the Supreme Court a quasi-administrative agency.

In the effort to avoid litigation and Federal control by means of interstate compacts or agreements, little progress has been made. Only four compacts in settlement of interstate water rights are in operation, and only one of these may be said, at the present moment, to be satisfactory. Many efforts to effect compacts have failed in negotiations, and there are 10 or more, now authorized or proposed, which appear to have little chance of becoming effective in the near future. Thus it appears that, on the whole, the settlement of interstate problems and the controversies resulting therefrom is not handled on a very satisfactory basis. A map accompanying this report shows the location of the more important interstate water problems as disclosed by Supreme Court decisions, compacts that are effective or proposed, and other interstate agreements.

The need of some other method of handling these problems is apparent. It is generally agreed that a national policy in regard to the utilization and control of water resources is urgently needed, and that some Federal agency should be created and

authorized to carry out and administer such a policy. It is generally agreed also that such a policy should be based upon the following factors:

Determination of the technical, economic, and social facts in each important river basin; an equitable apportionment of the interstate waters upon the basis of these facts; adjustment of these apportionments to meet changing conditions; and a program for the execution and financing of the necessary works. To place such a policy in action, with some Federal agency administering the same, will require overcoming some of the generally accepted limitations upon the power of the Federal Government, or finding some new basis or theory for such control.

Congress would undoubtedly have the power to authorize such a Federal agency to make plans for the complete coordinated utilization of the water resources of each important river system of the country and to make an equitable apportionment of the use of said waters. But to enforce the plans and findings of such an agency would be another matter, unless there was clear constitutional authority or unless the Supreme Court should adopt such plan or findings by decree, as the result of a suit instituted by the Federal agency. The plan and apportionment of use of waters would be in the nature of an adjudication of the water rights and would necessarily specify the preferential uses and the extent and manner of the use thereof.

The plan, if adopted by decree of the Supreme Court, would then be administered by the Federal agency, which would also be given ample administrative powers.

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SECTION III

V. INTERNATIONAL ASPECTS OF WATER ALLOCATION AND USE

The international problems of water use have become really pressing only within recent years when water development providing for the consumptive use of practically all of the available supplies of certain international streams, chiefly those flowing into Mexico, have been projected. Also related is the matter of extra-watershed diversions, which, when international streams are involved, raises many fine legal points.

United States—Canada

With a boundary of 3,500 miles, 2,000 miles of which is through waters mostly navigable, it is inevitable that there should arise between the two countries many questions regarding the use of these waters. From the Great Lakes westward there are a great number of streams which cross the border, flowing either into or out of the United States. Likewise on these streams questions are continuously arising as to the manner of use and diversion of the waters thereof.

Notwithstanding the many controversies that have arisen, involving the interests of States or Provinces, municipalities, corporations, or individuals on both sides of the boundary, all problems have been or are being solved in an amicable and satisfactory manner. This is due to the functioning of the International Joint Commission which has been in existence since 1912, and which was created under a treaty concerning boundary waters and questions arising along the boundary, signed January 11, 1909.

The International Joint Commission has judicial, administrative, and investigative powers. Its decisions on certain matters are final, and unique in that there is no review and no appeal. Questions are submitted to the Commission by the Governments for decision, but States, municipalities, corporations, or individuals may submit questions through their Governments. The International Joint Commission demonstrates the desirability of a special administration over international boundary waters, endowed with all necessary powers, whether they be judicial, administrative, investigative, or technical. The Commission provides a medium of direct communication between two great countries; it has the resources of a court of arbitration; and where a judicial settlement is impossible the way is still left open for settlement after investigation, report, and recommendation by the Commission to the two Governments.

With this the question of international water problems as relating to Canada may be dismissed, except to note the inference that a similarly happy solution of the proper adjudication of water rights with Mexico should be a matter of immediate concern.

United States—Mexico

Water-right problems with Mexico have been governed in the past by certain treaties and conventions which are now proving inadequate in the light of such major undertakings as the Colorado River development.

Looking toward a solution, the American section, International Water Commission, was authorized by act March 3, 1927, to cooperate with the Mexican section, in a study regarding the equitable use of the waters of the lower Colorado and lower Rio Grande for the purpose of securing information on which to base a treaty—and to report to Congress thereon. Studies and investigation were conducted and a report made to the Congress (Mar. 22, 1930). No formal international agreement resulted and the Commission was abolished (act of June 30, 1932). The powers, duties, and functions of this Commission were transfersed to the American section of the International Boundary Commission by the act above mentioned. This Commission was authorized to perform purely investigative functions, and to report to the Congress. No judicial or administrative functions were authorized.

There are two very important and difficult international problems with Mexico, one on the Colorado River and the other on the Rio Grande. These are the only two large rivers crossing the border or forming the international boundary. The only other water questions with Mexico are of minor importance, being in regard to the Tia Juana River and regarding floods in the border town of Nogales.

Colorado River

The international question here results from the fact that the Colorado River, while its entire water supply comes from a drainage area of 242,000 square miles in six States of the United States, also flows after crossing the international boundary, for about 100 miles through Mexican territory (18 miles as a boundary stream) before emptying into the Gulf of California. There are about 2,000 square miles in Mexico tributary to the Colorado River, but this area furnishes no water, and there are no tributaries of any kind in Mexican territory.

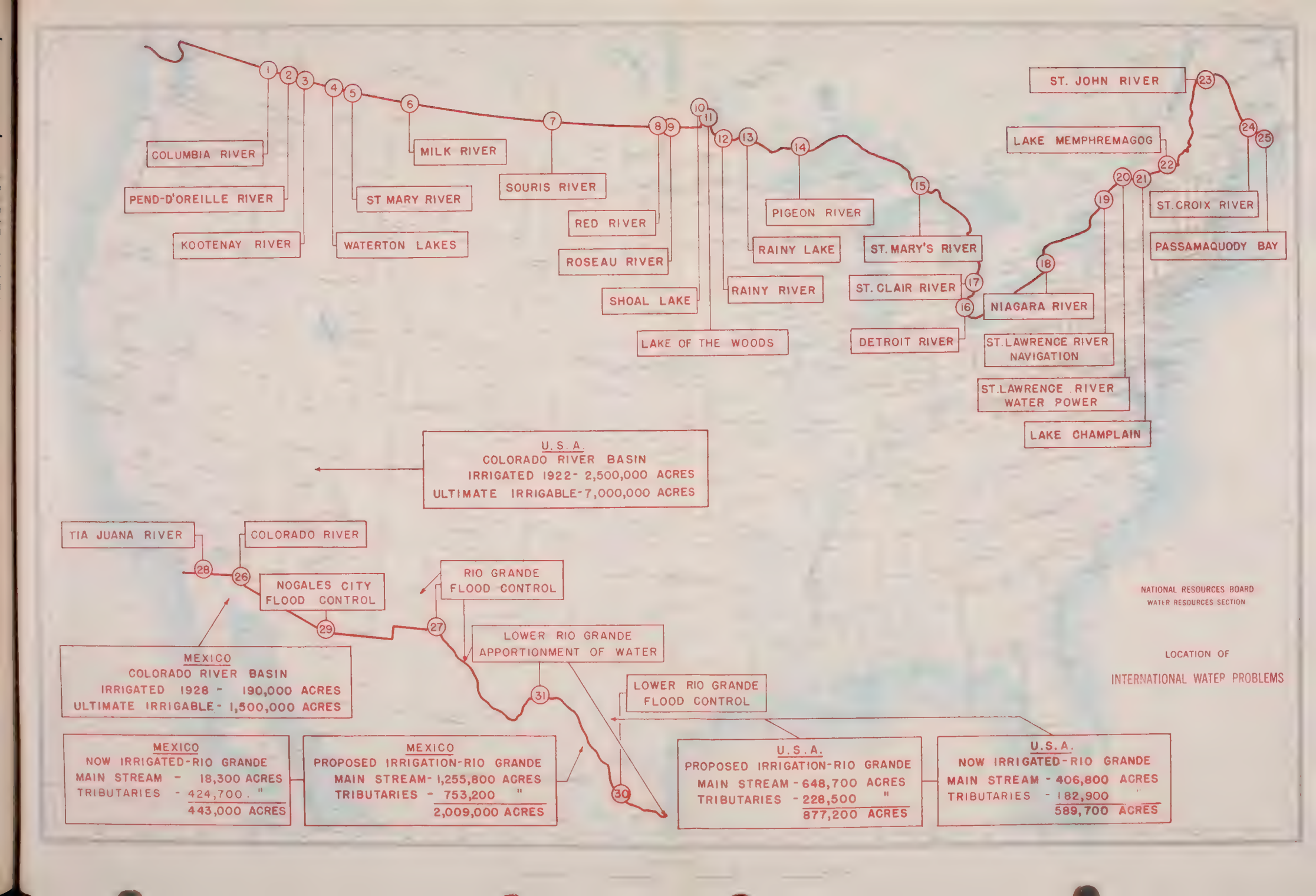
Existing Treaties: The Mexican Government bases its claim to the waters of the Colorado upon the fact that it is an international stream and upon certain treaties or conventions which relate in part to navigation on the Colorado River and on the Rio Grande.

However, with respect to the Colorado the treaties laid down no restriction upon the complete sovereignty of the United States over the river or its waters within its territorial boundaries; and imposed no obligation upon the United States to maintain the navigability of the river. Further, by common action of both countries navigation on the river has been abandoned in favor of irrigation.

Mexico's Position: Mexico during negotiations of the International Water Commission made various statements as to the amount of water claimed by that country; which varied from 3,480,000 to 4,500,000 acre-feet—based on an irrigable area of 1,500,000 acres.

Mexico considers the 750,000 acre-feet tentatively suggested as an appropriate allocation by the United States as notoriously out of proportion to her claims, and may be unwilling to agree to any settlement on this basis.

Situation in United States—Colorado River Compact: The compact attempts to effect a division of the waters of the Colorado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PEND-D'OREILLE RIVER
KOOTENAY RIVER
ST MARY RIVER
WATERTON LAKES
MILK RIVER
SOURIS RIVER
RED RIVER
ROSEAU RIVER
SHOAL LAKE
LAKE OF THE WOODS
RAINY RIVER
RAINY LAKE
PIGEON RIVER
ST. MARY'S RIVER
ST. CLAIR RIVER
DETROIT RIVER
NIAGARA RIVER
ST.LAWRENCE RIVER NAVIGATION
ST.LAWRENCE RIVER WATER POWER
LAKE CHAMPLAIN
ST. JOHN RIVER
LAKE MEMPHREMAGOG
ST.CROIX RIVER
PASSAMAQUODY BAY
U.S.A.
COLORADO RIVER BASIN
IRRIGATED 1922- 2,500,000 ACRES
ULTIMATE IRRIGABLE-7,000,000 ACRES
TIA JUANA RIVER
COLORADO RIVER
NOGALES CITY FLOOD CONTROL
RIO GRANDE FLOOD CONTROL
LOWER RIO GRANDE APPORTIONMENT OF WATER
LOWER RIO GRANDE FLOOD CONTROL
MEXICO
COLORADO RIVER BASIN
IRRIGATED 1928 - 190,000 ACRES
ULTIMATE IRRIGABLE- 1,500,000 ACRES
MEXICO
NOW IRRIGATED-RIO GRANDE
MAIN STREAM - 18,300 ACRES
TRIBUTARIES - 424,700 "
443,000 ACRES
MEXICO
PROPOSED IRRIGATION-RIO GRANDE
MAIN STREAM- 1,255,800 ACRES
TRIBUTARIES - 753,200 "
2,009,000 ACRES
U.S.A.
PROPOSED IRRIGATION-RIO GRANDE
MAIN STREAM - 648,700 ACRES
TRIBUTARIES - 228,500 "
877,200 ACRES
U.S.A.
NOW IRRIGATED-RIO GRANDE
MAIN STREAM - 406,800 ACRES
TRIBUTARIES - 182,900 "
589,700 ACRES
NATIONAL RESOURCES BOARD
WATER RESOURCES SECTION
LOCATION OF
INTERNATIONAL WATER PROBLEMS

at "Lee Ferry", between the upper basin and the lower basin within the United States. as follows:

	Acre-feet
(*a*) Apportioned upper basin	7, 500, 000
(*b*) Apportioned lower basin	7, 500. 000
Additional to lower basin	1, 000, 000
Total	16, 000, 000

The compact provides that in the event water is required for delivery to Mexico, it shall be supplied first from any surplus above the 16,000,000 acre-feet specified in (*a*) and (*b*), and if said surplus is insufficient for this purpose, then the upper and lower basins shall bear equally the burden of supplying the deficiency.

The compact provides merely for a division of the waters of the Colorado River system between the upper basin and the lower basin.

A matter of importance bearing on the international problem is the attitude of the seven States in the basin regarding a settlement with Mexico. Most of these States are strongly opposed to releasing to Mexico in excess of 750,000 acre-feet, taking the position that because the entire flow of the river is produced above the border, the United States has control of the water supply and is under no necessity of considering Mexican claims.

Examination of the various reports and discussions relating to the Boulder Canyon project and the All-American Canal fails to disclose any plan or proposal to provide Mexico with any water upon completion of said canal.

Imperial Valley Lands—Joint Use of Canals and Water: Irrigation of Imperial Valley lands in California is accomplished by a diversion from the Colorado River in the United States, the water being conveyed across the boundary line by a canal which runs 50 miles or more through Mexican territory before reentering the United States, and becoming available for the Imperial Irrigation District lands in California.

This arrangement was carried out under a contract between a Mexican company, the stock of which was owned by the California Development Co. (American), and the Mexican Government, being approved by the Congress of Mexico in 1904. Under this arrangement Mexico was entitled to one-half the water carried in the canal, and it is the basis for her claim for 3,600,000 acre-feet.

Irrigated-Irrigable Areas and Water Supply: Dr. H. T. Cory in his report as regional water consultant on the Colorado Basin estimates:

	Acres
Lands now irrigated in United States	2, 500, 000
Lands now irrigated in Mexico	200, 000
Ultimate irrigable area in United States	5, 800, 000
Ultimate irrigable area in Mexico	800, 000

As shown above, Mexico bases her claim for water on an estimated irrigable area in Mexico of 1,500,000 acres. Lands ultimately irrigable from the Colorado River in Mexico, if sufficient water were to be available, have also been estimated at 1,961,000 acres. (Report of American section International Water Commission. H. Doc. No. 369, 71st Cong., 2d sess., p. 91.)

The Rio Grande

The situation on the Rio Grande is the reverse of what it is on the Colorado. The international problem on the lower Rio Grande is from Fort Quitman, Tex., to the mouth. Above Fort Quitman all questions have been settled by a treaty signed May 21, 1906, by which the United States guarantees the delivery of 60,000 acre-feet annually to Mexico for lands in the El Paso-Juarez Valley.

A compact between Colorado, New Mexico, and Texas, signed February 12, 1929, and known as the Rio Grande compact, was approved by a representative of the United States and duly authorized by Congress. It provides that the *status quo* of waters in these States shall be maintained until July 1, 1935, at which time it is proposed to make another compact for a final equitable apportionment of all waters.

The water-right problem in the lower Rio Grande is more pressing and more difficult of solution than in the upper Rio Grande, because most of the irrigated area is in the United States, while the water therefor comes largely from Mexican sources. The problem in the lower Rio Grande can only be settled by treaty with Mexico, which will provide a plan for the equitable use of the waters of the basin below Fort Quitman.

Statistics—Irrigated-Irrigable Areas—Water Supply: A report of the American section, International Water Commission, indicates the following: Irrigated direct from Rio Grande, 425,100 acres, of which 406,800 acres are in the United States (91 percent in the lower valley) and only 18,300 acres in Mexico. Irrigated from tributaries, 607,600 acres, of which 182,900 are in United States and 424,700 in Mexico.

It should also be noted that it is proposed to irrigate an additional 1,904,500 acres directly from the Rio Grande below Fort Quitman. Of this acreage, 1,255,800 acres are in Mexico, and 648,700 acres are in the United States.

Records from United States and Mexican Government agencies, for the years 1924–28, indicate that 70 percent of the flow below Fort Quitman comes from tributaries in Mexico, while the United States is the source of the remaining 30 percent; that the estimated amount of water available is 4,864,000 acre-feet; and that the consumptive uses in 1929 were 1,012,000 acre-feet, leaving 3,852,000 acre-feet wasted to the Gulf.

Reservoirs: The report of American section, International Water Commission, states that there can be no further increase in irrigation along the lower Rio Grande without storage and regulation of flow. Mexico has ample reservoir capacity to regulate flow of tributaries, and has under way or constructed two reservoirs with a total capacity of 3,200,000 acre-feet. Apparently the sites considered by the American section were on the main stream and would require agreement with Mexico.

International Flood Control Projects—Rio Grande Rectification: The plan for the rectification of the Rio Grande in the El Paso-Jaurez Valley was provided for in a convention between the United States and Mexico dated February 1, 1933, and the amount of $3,300,000 has been allotted by the Public Works Administration for its prosecution.

Lower Rio Grande Flood Control: The Public Works Administration has allotted $2,000,000 for the beginning of the lower Rio Grande flood-control project. The plan for such flood-control works had been considered in negotiations of the United States and Mexico, which culminated in each Government's acceptance of the joint plan on October 3, 1932, by informal agreement.

Conclusion

There is little room for doubt that the problems set forth in this brief outline call for immediate and equitable solution. If considered as elements in the same international relationship, such a solution with respect to both the Colorado and Rio Grande basins should be practicable. The waters of the Colorado have their origin in United States territory, and the problem is one of a fair allocation to Mexican users. The waters of the lower Rio Grande have their origin in Mexican territory and the problem is one of fair allocation to users in the United States An international commission similar to that established for adjustment of boundary problems between Canada and the United States should be able to effect an amicable adjustment.

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SECTION III

VI. GOVERNMENT CONTROL OVER WATER RESOURCES IN CERTAIN EUROPEAN COUNTRIES

By Ole Singstad

On the occasion of a recent trip abroad, made in connection with other business, the writer was requested by the Water Resources Section to interview responsible government officials in several countries with a view to reporting upon the methods of administration and control over water resources practiced in those countries. The following report represents the result of observations made in Austria, Czechoslovakia, England, France, Germany, Italy, and Switzerland. An outstanding observation is that there is more or less complete control of all water resources by the national governments. The method by which the last feature is accomplished, as well as the agencies employed by the different countries, are briefly outlined in the following paragraph.

Austria

All water resources are under Government control exercised through the federal Ministry for Agriculture and Forestry. This ministry exercises control over the Hydrographic Central Bureau, which collects data on rainfall, stream flow, ground water, and air temperatures; operates a hydraulic laboratory at Vienna; and has jurisdiction over water-power development, navigable waterways, flood control, stream protection, water supply, drainage, and the forestry service.

There is a federal river commission in charge of regulating the Danube for navigation and other purposes.

Hydroelectric power plants are constructed under concessions, usually granted for periods of 37 years or 90 years. Many of these plants are owned by municipalities and by the Provinces, usually through public corporations. Four hydroelectric plants have been planned and built by the Ministry of Commerce and Communications for the operation of the railways under this ministry. However, these developments were also subject to the approval and supervision of the water resources bureau of the Ministry for Agriculture and Forestry.

Irrigation is not an important activity in Austria, but drainage is of considerable economic importance. The policy is to grant concessions to drainage districts subjects to control by the Government, which prepares the plans, exercises supervision of the works, and grants a subsidy of from 30 to 40 percent of the cost.

Concessions are usually granted by the Provinces, with the approval of the National Government, for flood-control and stream-protection work on the larger and navigable streams, and by local authorities for the smaller streams.

Czechoslovakia

All water resources of Czechoslovakia, except on small and unimportant streams, are under the control of the federal Government. This control is exercised under several different departments.

The Department of Agriculture grants concessions for water works, and to country districts and small towns for flood control and stream regulation on small streams where no navigation or hydroelectric power development is involved or possible. Such works are sometimes subsidized by the federal Government. It also grants concessions to drainage and irrigation districts, which may be subsidized to the extent of 70, 80, or even as high as 90 percent of the cost.

The Department of Public Health passes upon the technical and financial soundness of waterworks for cities and sanitary works. It also grants Government subsidies, not exceeding 50 percent of the cost, for such works.

The Department of Public Works exercises general control over water resources and specifically over navigable waterways, harbor works, and hydroelectric power development and administration. Under this department is also the National Hydrologic Institute, which is primarily a research, fact-finding, and statistical organization. It has 1,800 field stations for measuring rainfall, stream flow, ground water, and atmospheric temperatures. It makes technical investigations of the country's water resources with a view to their being developed and utilized in accordance with a comprehensive plan calculated to result in the greatest national economic benefit.

In 1919 federal legislation was enacted providing for the systematic electrification of the entire country according to a comprehensive and well-developed plan. Under this plan the Government builds and owns the hydroelectric plants, but does not operate them. For the purpose of the operation of the power plants and the systematic electrification of the State, the entire country has been divided into 20 districts, and a limited dividend corporation set up in each district. The stock of these corporations must be owned to the extent of 60 percent by public bodies, including the federal Government, the Provinces, municipalities, and townships. The balance of the capital ownership and management may be private.

England

In England the Government control of water resources is distributed among numerous governmental units and local boards and authorities operating under authority of Parliament.

Under the land drainage act of 1930, provision is made for the setting up of catchment boards for the main rivers of the country, and 48 have been established. Their function is to provide main channels for land drainage and to secure adequate water in their respective basins for the requirements of water supply. The boards are appointed by the Ministry of Agriculture and Fisheries after nomination by local authorities. The catchment boards have authority to prescribe a tax through the regular taxing authority for the purpose of carrying on their work, and the ministry may grant subsidies with the approval of Parliament.

The Ministry of Health passes upon projects for water supply, sanitary works, etc., and may of its own motion constitute in a catchment area a joint committee having the powers of a sanitary authority under the rivers pollution prevention act when it deems such procedure desirable.

All hydroelectric power projects in England must be authorized by special act of Parliament after having been approved by the Electricity Commission of the Ministry of Transport.

A central electricity board created by act of Parliament in 1926 is national in scope and controls the entire electric generating industry in England through the ownership and operation of the high-tension transmission system known as the "grid." The board, consisting of five members appointed by the Minister of Transport, operates as an independent body subject only to the control of the electricity commissioners in the issuance of its securities. It has power to compel owners of generating stations to enter into the national scheme.

The Thames Conservancy is a unique organization which has its origin centuries ago. As at present constituted it has 35 members and controls the Thames River from a point 18½ miles upstream from London Bridge to the source, covering 136 miles of the main stream and 400 miles of tributaries, and an area of 3,182 square miles. The members are appointed by the Minister of Agriculture, Minister of Transport, various counties, and other municipal subdivisions. This conservancy body exercises three functions: Navigation, land drainage, and control over pollution. It exercises rigid control for prevention of pollution, policing the smallest tributaries for this purpose. It provides facilities for navigation, such as dams, locks, and dredging of channels. It provides drainage by clearing the water sources of debris and silt, and provides against damage by floods.

France

Government administration and control here is divided among several departments; the Department of Public Works controls hydroelectric power development and electric transmission and distribution, navigable waters, flood control, and hydrological surveys; the Department of Agriculture controls drainage, irrigation, forestry, and water supply; and the Department of Health controls sanitary works. Control may also be exercised by special authorities created by legislative enactment, for the purpose of developing entire basins according to a comprehensive plan.

Flood-control and irrigation projects are as a rule carried out by local districts or associations formed for that purpose. The Government may grant subsidies to such districts, but it does not construct any small works of this character.

Control over water-power development is very much like that of Austria and Italy, private corporations operating under a concession from the government.

Rhone Valley Authority: The outstanding and practically the only case of an entire river basin of large proportions being developed in accordance with a comprehensive plan is in connection with the Rhone Valley Authority in France, where a publicly controlled, semipublic authority is charged with the duty of developing the entire Rhone Valley water resources. It was created by legislative enactment for the purpose of carrying out three primary functions; viz, navigation, irrigation, and hydroelectric development.

The four different groups participating in the financing of the authority are: (1) the city of Paris and the Department of Seine; (2) All communes, municipalities, towns, and other public bodies in the Rhone Basin; (3) the Paris-Lyons-Mediterranean Railroad Co.; (4) the large electric and industrial corporations of the basin.

These four groups are the stockholders to the extent of 25 percent each. The authorized capitalization is 240 million francs, of which 60 million have been issued. The law provides that for each block of one-fourth of the total authorized capital, which is paid up, the authority may issue nine times that amount in bonds, amounting at present to 540 million francs. The French Government guarantees the interest payments on the bonds, and in consideration thereof has a representation on the board of direction in the proportion of two-fifths of the total membership. The constitution, bylaws, and other working regulations of the authority were adopted and approved in 1933 and it has been active in preparing plans and is now ready to proceed with the construction of its first project.

Germany

Under the present Government there is a program in preparation, and partly in effect, for centralizing under the Reich the control and administration of all water resources of the entire nation. Prussia has for a long time had a well-organized Government control over all of its water resources; and the water resources of the nearby smaller states, constituting, together with Prussia, all of north Germany, have their water resources activities coordinated with those of the Prussian administration. The several south German States have each independent control within their boundaries. On certain streams, such as on the Ruhr, what are in effect conservancy boards have been created, under the authority of which complete all-purpose river development is effectuated.

The only department where a national control is now in effect is the federal Ministry of Transportation, which was organized on a national basis in 1921. It controls waterways, river regulation, and canalization, dams and locks, and hydroelectric power plants on navigable streams. On the nonnavigable rivers the State grants concessions for power projects.

At present only in Prussia does the Government exercise control over irrigation development, the Prussian Ministry of Agriculture having jurisdiction.

While all of the countries under consideration have a highly developed forestry service, Germany has recently adopted a program, centralizing under the Reich Government the control and administration of all the forest resources of the nation, and a very aggressive policy of national reforestation and forest preservation is now in effect. This program extends to private lands. It will prevent deforestation of private forest lands and requires all waste land not suitable for agriculture to be reforested. The program is supported by Government credits at low interest rates.

Italy

Italy has a Department of Public Works divided into six divisions, one of which is in charge of water resources and hydroelectric power development. This division has complete control over the utilization of water for every purpose, and maintains regional bureaus in charge of different areas of the country. There are no boards, commissions, or other agencies outside of this department concerned with the development of any river or basin. The six divisions are:

First division: In charge of water resources and hydroelectric power development.

Second division: In charge of harbors and roads.

Third division: In charge of the construction of Government buildings, sanitary works, cemeteries, and opening of new streets in cities.

Fourth division: In charge of special services such as damage by earthquake, strengthening of buildings, subsurface investigations.

Fifth division: In charge of planning and building railroads.

Sixth division: General administration of the department.

The Department of Public Works has a superior council, to which all projects are referred by the minister for determination. In form, the superior council acts in an advisory capacity, but in practice its determination is followed. The superior council is divided into 4 sections, each section having a membership of about 30. Each section has a president and the majority of the

membership is made up of officials of the Department of Public Works, but there are in addition a few (six) members who are not full-time Government officials, selected for their expert knowledge in certain fields. More than one-half of the membership of the superior council are engineers; the balance are lawyers, outside experts, and three generals of the army.

The four divisions of the superior council are in charge of the following classes of work:

First division: Roads, bridges, buildings, damage to buildings.

Second division: Flood control, forestry work, land reclamation by irrigation and drainage, aqueducts, sewers, and maritime works.

Third division: Utilization of water resources and projects for generating and distributing electric power.

Fourth division: Railroads, tramways, cableways, public automobile services, and inland navigation.

The weather forecasting is done by the Department of Aeronautics, but the hydrological survey branch of the Department of Public Works, where stream flow, rainfall, and air temperatures are measured, cooperates with the Departments of Aeronautics and Agriculture in gathering information for the weather bureau.

The Government policy is to grant concessions to private corporations for the utilization of water and for the construction of hydroelectric generating plants, subject to approval by the Department of Public Works. The corporation pays a royalty to the Government, and at the expiration of the concession period the structures revert to the Government.

A proposed irrigation project must apply to the Department of Agriculture for a Government concession. If approved by that Department the project next goes to the Superior Council of the Department of Public Works, which may modify, approve, or disapprove the project. If approved, the plans are subject to approval of the Department of Public Works. The Government grants a subsidy of 75 percent of the cost of an irrigation district project, and the water and structures are considered the property of the Government, which audits the accounts of the district and exercises control over the rates charged the water users.

The Department of Public Works operates a hydrographic service which collects hydrometeorological data of such unusual merit as to warrant a fuller description than can be presented in this summary. A brief description of this service is attached to this paper as an appendix, and is reprinted from an article by Robert E. Horton in the bulletin of the American Meteorological Society, for June-July, 1933.

Switzerland

Control over water resources is divided between the Federal Government and the Cantons. Federal control is exercised through two departments; the Department of the Interior having jurisdiction over forestry, flood control (not connected with navigation or power), and the meteorological service and the Department of Communications having jurisdiction over hydrography, water-power development, navigation, regulation of the waters of lakes, and industrial uses.

Complete jurisdiction rests with the Cantons with respect to irrigation, flood control, water supply, and sanitary works. However, since the Federal Government as a rule grants subsidies for such work, it must approve the projects and thus exercises general supervision through the Department of the Interior.

All hydroelectric power developments under whatever ownership must obtain concessions either from the Federal or the Cantonal Governments. Fully 70 percent of the electric generating capacity of the country is publicly owned, either directly by Cantons, cities, or communities, or indirectly by public corporations. The Government owns only those plants which produce power for the federal railroads.

Summary

The salient points brought out in the reports which formed the basis for this abstract are: (*a*) In all countries visited, there is a more or less complete governmental control of all water resources; (*b*) three out of seven countries have a department of public works which controls the conservation and utilization of water resources; (*c*) hydroelectric power plants and the electric generating industry in general is, with the exception of Italy and England, to a large extent in public ownership; (*d*) all countries have a highly developed forestry; (*e*) land drainage and irrigation is usually done by local districts under Government concessions; and (*f*) all governments exercise rigid control over stream pollution.

The only case of a public corporation or authority, national in scope, is the Central Electricity Board in England which controls the electric power generating industry of the entire country through the ownership and operation of the high-tension transmission system known as the "grid."

The outstanding and practically the only case of an entire river basin of large proportions being developed in accordance with a comprehensive plan is the Rhone Valley Authority in France where a publicly controlled, semipublic authority is charged with the duty of developing the entire Rhone Valley water resources in accordance with a comprehensive plan.

APPENDIX

Hydro-Meteorological Reports of Italy [1]

The *Annali Idrologici* or Annual Report of the Hydrographic Office of the Minister of Public Works of Italy is so unusual in many ways as to suggest the standardization of reports on hydrometeorology and hydrology gotten out by other Governments along similar lines.

Considering first the hydrometric records. There is given for each gaging station on the principal rivers of Italy:

1. A small map showing the precise location of the gaging station.
2. A cross-section of the stream channel at the gaging station.
3. A table of discharge measurements, giving stage discharge and other data for each measurement.
4. Rating or stage-discharge relation curves.
5. A table of daily discharges for the year.
6. A table of monthly run-off for the year.
7. A table showing the frequency and duration of different daily discharge rates.
8. A diagram containing a hydrograph of daily flow and also a daily flow duration curve.
9. Duration curves for individual months.
10. A hydrologic balance sheet, showing graphically for each month the rainfall and run-off. The rainfall data used in deriving the balance sheet appear in another part of the report.

Corresponding reports on stream gaging in the United States and Canada contain, in general, only two of these items, in

[1] From a review by Robert E. Horton, Bull. Am. Met. Soc. June-July 1933.

addition to a brief description of the gaging station, viz, daily discharges and monthly run-off data.

Turning to the meteorological portion of the report there are given in relation to rainfall:

1. An excellent table of rainfall stations, including a statement of the type of rain gage, with brief descriptive notes.
2. Monthly rainfall and number of rainfall days per month at all stations, arranged by drainage basins.
3. Tables showing the monthly distribution of rainfall by daily amounts.
4. Number of rainfall hours at stations with recording pluviographs.
5. Maximum rainfall for different numbers of consecutive days.
6. Minimum rainfall for different numbers of consecutive days.
7. Various other tables of rainfall data, particularly data of rains of high intensity for different intervals.
8. A table showing depth of accumulated snow at different stations in the principal drainage basins at 10-day intervals during the winter.
9. A table showing mean precipitation in different altitude belts in each drainage basin and the total volume of annual precipitation.
10. A table showing for each principal station and drainage basin the total rainfall in millimeters and the equivalent liters per second per square kilometer.

The last forms the basis for the rainfall data used in perparing the hydrologic balance sheet.

The report is accompanied by a general rainfall map, remarkable alike for its wealth of detail, its clarity and its pleasing arrangement and coloration. It is a model of cartographic excellence.

In addition to the preceding there are many other data, including data on turbidity and silt content of streams. One section of the report is devoted to ground-water levels and contains the data for numerous stations, classified by drainage basins, with adequate location maps and descriptions of each station.

Here one finds assembled in a single report all of the fundamental data required for 1 year for almost any analysis of a given drainage basin, and not only does the report contain the basic data or raw materials, but the data are analyzed and results presented in such form as to permit of their application to any problem in the simplest possible manner. Compare this situation with that usually prevailing where a study of the hydrology of a given drainage basin is to be undertaken. The steps usually necessary involve, first, the compilation of the basic data from a long list of reports issued by different bureaus. As a rule, some of the information needed is not published, and reduction of the data to a working form comparable with that in which it is presented in the Italian hydrographic reports might involve, as the writer knows from experience, months of tiresome labor and thousands of dollars of expense.

Using data as ordinarily published in America, any one who wishes to check back to the original sources and compare published discharges with gage heights and discharge measurements will find himself often confronted with practically insurmountable difficulties. When his work is done, the results are not published. A new problem comes up on the same stream, handled by different persons, and all this preliminary work is and must in general be duplicated.

As regards excellence of paper, format, and typography, as well as character of the data presented, the Italian report is one which is certain to give a thrill of joy to anyone who takes delight in seeing the results of scientific investigations admirably presented. A comparison of this report with those published in America is in no way favorable to the latter. Naturally the question arises: If the Italian Government can afford to get out its hydrometeorological data in the excellent and attractive form above described, why cannot other countries, particularly the United States and Canada, undertake publication of similar data in an equally complete and attractive manner? Not only could an enormous amount of labor and expense be saved in the application of the data, but the danger of serious errors through inadequacy of published data could be greatly reduced.

One cannot help but admire the efficient and complete manner in which those responsible for the publications of Annali Idrologici have met in a practical way the needs of those for whom the data are really compiled. Evidently bureaucratic perquisites and convenience have played no part whatever in their considerations.

It is not the writer's desire to offer criticism further than to point the way to better results in other countries, particularly the United States and Canada. It would seem, however, that the need for revision of methods of publication of hydraulic and meterologic data is so urgent and the possibilities of accomplishment so great, that the matter is one which might appropriately be taken up by the sections of hydrology and meteorology of the International Geophysical Union or some other adequate organization, with a view to bringing about better and more complete publication of such data. Should this be done the Italian reports may well serve as a model.

A HALF MILLION WORDS!

That's what you see pictured above and what the Water Resources Section saw when it undertook the work of preparing its final report to the Nationa lResources Board. Regional Reports and Special Studies in all manner of form and fact were digested. These digests were then abstracted and those abstracts reworked. The half-million words thus became the seventy thousand that tell the story of Water Resources in relation to National Planning.

PART IV

REPORT OF THE PLANNING COMMITTEE FOR MINERAL POLICY

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LETTER OF TRANSMITTAL

PLANNING COMMITTEE FOR MINERAL POLICY

To the CHAIRMAN, The NATIONAL RESOURCES BOARD.

DEAR SIR: In response to the request of the National Planning Board, there is herewith presented a preliminary report of the Planning Committee for Mineral Policy, appointed by the President April 7, 1934, to be included as a part of a report of the National Resources Board to the President.

The present report is a preliminary statement of the major elements of policy, with recommendations for action on a few of them, but without specific recommendations on many questions that are still under consideration.

At a later date the committee plans to prepare a fuller report for submission to the President.

The committee wishes to acknowledge the cordial cooperation of all the official agencies in the Government concerned with minerals. These include the Bureau of Mines, the United States Geological Survey, the Bureau of Foreign and Domestic Commerce, the Economic Adviser's Office of the State Department, the Office of the Special Adviser to the President on Foreign Trade, the Tariff Commission, the Industrial Planning Branch of the War Department, the Petroleum Administrative Board, the Science Advisory Board, and the Division of Research and Planning of the N. R. A. We are particularly indebted to F. G. Tryon, O. E. Kiessling, A. G. White, D. F. Kneipp, C. E. Stuart, J. W. Frey, R. J. Lund, R. A. Cattell, Daniel Harrington, G. S. Rice, Herman Stabler, J. D. Northrop, and D. F. Hewett. Also there have been individual conferences with leaders in the mineral industries, but limitation of time on this preliminary report had made it impossible to extend these conferences as far into the industries as is hoped for later.

Respectfully submitted.

C. K. LEITH, *Vice Chairman.*
HERBERT FEIS.
JOHN W. FINCH.
J. W. FURNESS.
C. T. HARRIS, Jr.
LEON HENDERSON.
W. C. MENDENHALL.
F. A. SILCOX.
WAYNE C. TAYLOR.
W. L. THORP.
WILLIAM P. RAWLES, *Technical Secretary.*

NATIONAL RESOURCES BOARD REPORT

PART IV
INTRODUCTORY SUMMARY

Salient Features of Report*

(1) The fact that mineral resources are exhaustible and irreplaceable is an essential consideration in a national mineral policy. Conservation is defined and analyzed. Better coordination of private and public effort is required.

(2) Consumption forecasts are the cornerstone of planning.

(3) Need for control of production, price, or capacity discussed for oil, coal, copper, lead, and zinc, without specific recommendations as to kind of measures. Need is clearly established for coal and oil. Enabling legislation recommended.

(4) For minerals in deficient supply within the United States, encourage development. Methods are specified. Discourage use of tariffs as a method.

(5) Minerals and the problem of monopoly are discussed. Antitrust laws should be retained and vigorously enforced, with provision for authorizing collective action to control wasteful competition under public supervision.

(6) Possible extension of leasing laws on public lands to cover all minerals, except for that portion of Alaska outside of the national forests.

(7) Broad extension of Government or State ownership is not approved, with special exceptions.

(8) Development of submarginal deposits is to be encouraged only for minerals in deficient supply. Necessity of making provision for permanently stranded mining populations. Relation to land-use planning indicated.

(9) Taxation. Discovery and depletion allowances in income tax, designed to encourage development of minerals, to be studied as to their effect on the problem of production control. Anticonservational effects of State ad valorem taxes on reserves are discussed; study to be made of possible revision.

(10) States should be encouraged to exercise their constitutional authority to prevent resource waste by use of the police power.

(11) Government to sponsor scientific and engineering attack on problems of conservation and cost reduction.

(12) Safety and health of mine workers. Protection a primary obligation of Government.

(13) Federal agencies of mineral administration and their possible organization discussed.

(14) Foreign policy to be based on grouping of minerals into those in deficient supply and those in exportable surplus. Kinds of policy recommended for each of these groups.

(15) Imported minerals and national defense. Necessary to provide stocks of certain minerals now lacking in this country.

(16) Mineral tariff policy and reciprocal trade agreements to be considered in light of occurrence and extent of domestic reserves.

(17) Continue to seek equality of opportunity for American nationals in development of needed supplies abroad.

* An abstract of the Committee's report will be found on pages 32 to 35

SECTION I
THE NEED OF A NATIONAL POLICY

The United States leads the world in variety and abundance of its mineral deposits. No similar area contains as great a number of mineral deposits of such large size, high grade, and easy accessibility. It produces about 40 percent of the value of the world mineral production from within its own borders, and its commercial control of mineral resources in foreign countries brings its proportion of the world total up to 50 percent. It has shared with the British Empire in the exploitation of over three-quarters of the world's minerals. Through its use of mineral fuels and water powers, it produces nearly half of the mechanical energy of the world. Minerals account for about 40 percent of the value of the annual product of natural resources in the United States, which include its agriculture, forests, and water powers. In 1929 the mineral industries employed more than a million men and reported products to the value of nearly 6 billion dollars.

Mining is the stepchild of our economy. Rightfully it is coordinate with agriculture and manufacture; actually, it receives insufficient attention. Ours is the age of the power machine and the minerals furnish both the power *and* the machine. Not only is the United States the largest producer of minerals; it is also the largest consumer. Our per capita requirements of metal and fuel far exceed those of any other nation. Until recently consumption has increased like a sum at compound interest, so that in the last 30 years we have used more oil and coal, iron, and copper than in our entire previous history. While the rate of increase slowed down after the war and while consumption is now reduced by the depression, the future of our industries depends on an abundance of cheap metal and cheap fuel.

In the happy stage of skimming the cream of the resources, the Nation has taken its abundance of mineral supplies as a matter of course. But as we pass into the stage of maturity it is evident that the spendthrift habits and impetuous expansion of the pioneer days must give way to a more orderly and less wasteful development. The great mineral industries of the United States have been built up through individual initiative, with little social direction or control. Until recently it has been assumed that private enterprise required no guidance in developing the national resources and needed no help from Government. The World War, however, made people acutely conscious of their dependence on the minerals, and in the case of the fuels led to an elaborate machinery of wartime control. Following the war expansion came a difficult readjustment. Abroad, our trade in minerals was disturbed by the tide of economic nationalism, expressed in the spread of public controls of one kind or another. At home, coal, oil, and certain of the metals struggled with an unmanageable surplus of plant capacity. The difficulties of the mineral industries were brought to a crisis by the great depression.

The situation calls for review, to see whether it warrants better coordination of national policy in the public interest. The following report considers this question.

We shall make no attempt to discuss the many economic and social conditions that affect mining in common with other industries. The Nation's interest centers very largely around the 1,000,000 men and their families who are dependent on the mines for a living. The public is rightly concerned with the arduous life of the mine workers, their isolation, and their long struggle for the right of collective bargaining; with the immense fluctuations in employment; with living conditions that are sometimes healthful and comfortable, yet sometimes miserably poor. The committee is informed that the questions of employer-employee relations and of economic security for the unemployed and the aged are being considered by other agencies and are outside its terms of reference. We cannot, however, forbear a consideration of the stranded populations in some mining districts or of the special problem of health and safety. In general, the task assigned to this committee deals with mineral technology and markets. Yet the economic stability which we find the most urgent first step in preventing resource waste is also a prerequisite to ameliorating the lot of the mine workers.

Our discussion is concerned primarily with questions of policy arising from the inherent characteristics of mineral resources. Among these characteristics are: (1) That minerals are exhaustible and nonreproducible; (2) that some minerals do not exist in the United States in quantities adequate for national welfare; (3) that others exist in present surplus; (4) that geographic distribution is fixed by nature and cannot be changed by enactment, thereby determining trade routes and trade areas, both domestic and foreign; (5) that there are

special hazards, both physical and economic, in mining; (6) that closing down a mine may result in losses far more serious than closing down a factory. The outstanding public problem arising out of these conditions is that of conservation. By conservation of minerals, we mean not hoarding, but orderly and efficient use in the interest of national welfare, both in war and peace, without unnecessary waste either of the physical resources themselves or of the human elements involved in their extraction.

The task in mineral conservation now before the Nation is to take up and carry forward the work begun under the leadership of President Theodore Roosevelt 30 years ago. The original conservation movement had two major objectives: (1) Protection of the public domain against despoiling by private interests, and (2) prevention of physical waste. Indignant at the frauds and evasions practiced under the old land laws, the friends of conservation attacked the first objective with zeal and vigor. Unappropriated mineral-bearing lands (except for the metals which were open to location as before) were withdrawn from settlement pending their classification and the enactment of new legislation. After prolonged debate, Congress passed a group of leasing acts, including the Alaskan coal land act of 1914 and the mineral leasing act of 1920, opening deposits of coal, oil, gas, phosphate, and salines on the public domain to prospecting and leasing with payment of royalty to the United States. With the passage of these laws, the first objective of the conservation movement was largely attained, so far as minerals were concerned, though there will always remain the task of vigilant and courageous administration.

But with respect to the second objective—the prevention of physical waste—much remains to be done. Great and encouraging savings have indeed been made by engineers and scientists. Thus, the invention of the process of flotation has recovered large quantities of metal formerly wasted. In the production of oil, the technical men have learned how to cement wells against infiltration of salt water, how to utilize the lifting power of the imprisoned gas to increase the yield of oil, and have carried the maximum depth of drilling from 3,000 to 10,000 feet. The cracking process has doubled and trebled the percentage of gasoline obtainable from the crude. In the field of power generation, the fuel engineers have reduced the average consumption of coal from 5.3 pounds per kilowatt-hour in 1908 to 1.5 in 1933. These and other brilliant technical achievements have made available deposits formerly considered unminable and have greatly prolonged the life of our limited reserves. Among other things, they have shown the wisdom of conservation, for a barrel of oil saved for use today will generate four times as many horsepower-hours of work as it could have done 30 years ago.

But, as regards the waste of resources associated with the economic organization of mining, inadequate progress has been made. The waste of gas, oil, and coal now going on which is directly ascribable to the destructive competition characteristic of these industries, deserves the measured use of the word "intolerable." These wastes are not due to lack of engineering knowledge—our mining engineers and oil technologists are the best in the world. They are due rather to continuance of the literal application of the rule of competition to the development of these resources, and also, the special case of oil and gas, to the conflict between in the legal facts of surface ownership and the natural facts of geology. The present-day problem of conservation is to encourage an organization of industry that will control competitive waste. It involves, in the case of oil and gas, using the States' police powers to prohibit preventable waste and substituting the principle of the equitable share in the common reservoir for the judicial "law of capture." It involves permitting the control of production, stocks, capacity, and perhaps of price, under public supervision, by methods hitherto thought to be forbidden under the antitrust laws. The Nation must learn that the rule of uncontrolled competition applied to certain resources leads to excessive waste. The greatest single task of conservation is to insure economic stability in the mineral industries.

There is a wide-spread impression that waste is a thing of the past. Every school boy is taught how our pioneering fathers burned natural gas in great open torches 50 years ago. In point of fact, the wastes of that time were probably small compared with what is going on in the month of October 1934. As this report is written, in one field of the United States, a billion cubic feet of natural gas is being blown into the air daily. That is gas enough to supply the United Kingdom twice over. It is forty times as much gas as all the Scandinavian countries use together. It is almost enough to supply every householder in the United States now consuming either natural or manufactured gas. The only use made of this particular gas is to strip it for the tiny fraction of gasoline which it contains, and this at a time when the supply of gasoline from other sources is already so great that measures to limit production are thought to be necessary. Similar wastes, though fortunately on a smaller scale, are going on in other gas fields and in other industries, to which we shall later refer. It is probable that during the time it would take the ordinary person to read over this report, enough fuel will have been wasted in our gas and oil fields and coal mines to keep at least 10,000 relief families warm during the coming winter.

Were our resources unlimited, such losses might seem excusable. The facts are otherwise. Despite the dif-

ficulties of estimating reserves and the shortcomings of some past efforts, it is the consensus of geologists that the principal mineral regions have now been found; their general extent is known; in many cases their size has been measured. The geologic and geographic limitations upon further large developments are becoming fairly definitely understood. The rapid increase in the scale of production in the last few decades brings a new perspective into our judgment as to what constitutes adequate reserves. It is now established beyond reasonable doubt that the United States is deficient in many minerals necessary for industry, both in respect to present and to future requirements; that for others the supply is limited to a decade or a few decades; that, aside from the building materials, only a few of the minerals, such as coal and iron, exist in quantities sufficient to supply the Nation for long periods of 100 years or more, and even these are more limited in regard to the higher grade reserves. Present overdevelopment of some minerals has tended to obscure the central and dominant fact that, in relation to what we hope will be the life of the Nation, our mineral supplies are too limited to excuse the wasteful exploitation that now often prevails.

In approaching the problem of a national mineral policy, the committee starts with recognition of the fact that private industry has successfully developed the minerals of the United States to an extent never before approximated in the world; that the job on the whole has been done efficiently and without greater wastes or mistakes than were more or less inevitable under existing conditions of enforced competition and widely scattered ownership of the resources; that the desire for efficiency and profit has been mainly responsible for the great gains in conservational practice already made; that the nature and immense diversity of the problems—scientific, technical, economic, and social—have required a variety, elasticity, and boldness of attack scarcely possible under bureaucratic control, even if it be assumed that such control were competent, honest, and not hampered by shifting political currents. American consumers have been furnished the cheapest fuel and some of the cheapest metal in the world. The output per worker in the mines of the United States is generally far higher than in foreign countries. We believe that the record of the mineral industry in the United States warrants the presumption that it should continue to develop under private initiative. However, we also believe that mineral reserves are vested with a public interest which justifies extension of public supervision to those specific conditions affecting our mineral industries, which are distinctly detrimental both to the public and to the industries themselves, and which seem beyond the power of the industries themselves to remedy.

Soon after the passage of the National Industrial Recovery Act, several of the mineral industries embraced the opportunity to undertake collective action, under the public guidance and supervision afforded by the new law. Problems were taken up, in cooperation with the Government, which either because of the prohibitions of the antitrust laws or because of economic conditions associated with the depression had proved beyond their own capacity to master. It is mainly the conservational aspects of these questions that the committee has in mind in its discussion of possible extension of public regulation or control, Federal or State. By public control we mean not so much the forcible public interference with private business, as the addition of safeguards and powers to enable industry itself to act collectively, where necessary, in order to avoid the wastes, physical and social, of destructive competition.

Many agencies of Government, Federal, and State, permanent and emergency, touch the problem of conservation in one way or another, and progress has been made in the solution of the problems of individual industries. The various agencies now attempting to formulate a national program for land use are necessarily giving some thought to the minerals. The National Industrial Recovery Act is designed, among other things, to conserve natural resources, as well as human resources, and notable progress has been made in conserving oil. However, only a start has been made. Neither the N. R. A. nor any other agency has worked out the guiding principles, and naturally there is no consistent plan common to all of the agencies. The complex inter-relationships of minerals have scarcely been considered. No individual policy for coal, oil, or gas, for instance, can be worked out or administered without consideration of their inter-relations in a highly competitive fuel market. The same is true of the shifts in demand and the substitutions which are taking place among the major metals. A similar lack of a unified approach characterizes our activities touching minerals in the foreign field. All agencies of the Government dealing with foreign trade, or with national defense, are concerned with the minerals, yet policies hitherto have all too often been haphazard and even contradictory. Tariffs and reciprocal trade agreements, commercial treaties, foreign concessions and investments, the American attitude toward the "open door", all need review in the light of our present supplies and future reserves of the minerals.

Long-range considerations will dominate the discussion, though the special conditions of the depression cannot be overlooked We shall consider first the problems raised in the domestic field, and then take up those in the foreign field.

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POLICY IN THE DOMESTIC FIELD

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SECTION II

I. DEPLETION AND THE GROWING HANDICAPS OF MINING

In the domestic field the central problem is the wise use of the national inheritance with regard not merely to the prosperity of the mining companies but the welfare of the army of mine workers and the long-time interest of the consuming public. Here the problem centers around the facts of limited occurrence and exhaustibility. At the moment attention of the mineral industries is preoccupied with the handling of an embarrassing surplus, but the surplus is a short-time problem, in itself causing waste of the resources through destructive competition and thereby intensifying the long-time problem of mineral depletion.

The real significance of mineral exhaustibility is the tendency to force an increase in cost. When the Nation became conscious about the turn of the century that its mineral reserves were not inexhaustible, men pictured a day of wrath when all the coal and all the iron would be consumed. Then when the looked-for shortage did not occur, a feeling rose that conservation was a cry of "Wolf!" and a reaction set in. To get a rational picture of the problem of conservation, it must be fixed in mind that the danger is not absolute exhaustion in some distant future, but rather an early increase in cost through depletion of the rich and accessible deposits. The mines grow deeper and the ore bodies leaner. Exhaustion of thick coal beds forces the use of thin ones. Once famous districts pass into decay, and except as the discovery of new deposits or the advance of technology offsets the growing difficulties of nature, costs tend to increase. The American people have attacked their unique endowment with an energy and also with an impetuosity hardly equaled in the world's history. Thus far, as the old areas of production were exhausted, new sources of supply have been at hand, technology has been gaining over the forces of nature, and on the average costs have been going down. The immediate outlook is abundance of the principal mineral raw materials at declining cost.

But if a longer view is taken, the outlook is a formidable increase in the physical handicaps of mining and a rise in costs. Already signs begin to appear that domestic industries are feeling the pinch of competition and finding it difficult to meet the pressure emanating from younger countries that are still discovering new resources. For the construction materials—stone, clay, sand, and other earth products—our reserves are indeed inexhaustible. But for the metals and fuels, despite a magnificent endowment, depletion is further advanced than even mining men generally realize.

Of the 33 metal-mining districts that have yielded the greatest wealth to date only 5 have been discovered since 1900 and none at all since 1907.[1] In gold the peak of American production was passed in 1915, and despite the enormous stimulus of falling commodity prices and devaluation of the dollar, production today is still far below the pre-war level. In silver, also, we seem to have passed the peak. Large supplies are indeed assured as a byproduct of the winning of the base metals, yet where will be found the camps to take the place of the Comstock Lode or Leadville? In the mining of copper the riches of Utah and of the Southwest obscure the troubles of Michigan and Butte. The mines of Michigan have gone a mile below the surface, by far the deepest copper mines in all the world, and at those depths, despite the ablest of engineering, they are quite unable to compete with many low-cost districts here and abroad. Hence the telltale demand for a tariff. In lead and zinc depletion is far advanced, and despite large known reserves, the geologist would find it hard to tell where the supplies of 20 years hence will be found. In iron ore the incomparable Mesabi range, opened in 1893 has already yielded nearly half of its really high-grade ore, and the rest will hardly last another 40 years, though fortunately there are huge tonnages of low grade.

In the oil industry the glut produced by east Texas makes us forget the hundreds of dead or dying pools in other areas. It now appears that American oil deposits may not be the world's greatest; our distinction seems likely to be rather that we have used them up the fastest. In the Appalachians, Illinois, Indiana, and many of the earlier districts of the midcontinent and California, there is small prospect of new discoveries to offset the advance of depletion. A similar condition prevails in natural gas. The youthful vigor of the astonishing fields of the Southwest hides the decline of many eastern districts and the death of the Indiana gas belt.

Even if one turns to coal mining, he finds signs that point along the same road. The anthracite fields of

[1] The reference is to date of first discovery of the district, not necessarily to beginning of production. In several of these major districts there have of course been notable extensions, such as the Picher field in the Tri-State zinc and lead district.

Pennsylvania, home of our highest-priced coals, are 29 percent exhausted, and already the industry has passed into the stage of increasing costs. In the bituminous fields there are indeed stupendous reserves of low-grade coals, yet in many of the high-grade seams depletion is far advanced. The glories of the Moshannon bed are a memory. Only a few acres of virgin coal remain in the famous Big Vein of Georges Creek The life of the Pocahontas and New River coals is good for two and a half generations, that of the Pittsburgh seam in Pennsylvania for perhaps three.

The experience of England shows how early in the exploitation of a mineral resource the stage of increasing cost may arrive. In the first half of the nineteenth century, the United Kingdom led the world, not only in coal and iron but in the production of copper, lead, zinc, and tin. In none of these metals are Britain's reserves wholly exhausted; yet the mining of copper and zinc has all but ceased and that of lead is small. The mining of tin continues but only in declining volume. In coal, according to the very careful estimates of the British geologists, only 7 percent of the original reserve in the United Kingdom has thus far been removed. Yet, in the course of winning that 7 percent, the British miners have been forced to work at depths as great as 3,700 feet and to use, at shallower depths, seams as thin as 14 inches. If such be the cost of winning the 7th percent, what will be the cost of the 97th percent? Largely because of these handicaps—though partly because of less effective use of machinery—the British miner produces only about a fourth as much as the American miner. The result is twofold: The British miner receives less for his labor and the British consumer must pay more at the pit-head for his coal. A ton of soft coal in America costs 1.7 hours of labor; in England, 7.5 hours. The increasing difficulties in the British coal mines have long since absorbed the gains of technology, and the output per worker has been falling since the eighties. A land in the stage of increasing costs of mining is hard pressed in competing with some newer lands in the fortunate stage of declining costs.

American mining is starting on the same road. Symptoms of advancing age are becoming clear. Production of key minerals shows signs of migrating to newer countries. Mineral exports are declining in relation to mineral imports. Until recently most of our larger mineral industries were content to remain upon the free list, amply able to compete in the world market. But in 1932, three of the largest—anthracite, copper, and petroleum—asked for and received protection. Today 63 percent of our mineral production has sheltered itself behind the wall of a protective tariff. The handicaps of thinner beds, leaner ores, and growing depth are beginning to be felt. The problem of conservation is not to prepare for a day centuries hence when all the fuel and metal shall be gone, but to minimize the readjustment to a stage of increasing cost which in the older lands has already arrived and in the United States is only a matter of time.

What is to be done? The broad answer is clear: Eliminate waste and improve mineral technology.

An economic organization of the mineral industries must be encouraged that will minimize the resource wastes and the business losses of destructive competition. Tax, tariff, and public-land policies should be reviewed in the light of their effects on resource use, and conservation. The States should be encouraged to use their constitutional authority to prohibit waste by the exercise of the police power. The arts of exploration, mining, and metallurgy must be fostered so as to offset the progress of exhaustion and the growing obstacles of nature. In all such action the liberties, health, and living standards of the mine workers must be guarded as a primary obligation.

Unless these things can be done, the menace of increasing costs, in time, will handicap American producers, press heavily on miners' wages, raise costs of the raw materials of industry, and in many indirect ways work to handicap the national welfare.

SECTION II

II. FORECASTS OF MINERAL CONSUMPTION

Wise use of the national resources requires a knowledge of demand. Development of mines in excess of demand forces resource waste, capital loss, and irregular employment, and among the major causes of overdevelopment has been the lack of any clear picture of future requirements. Development programs have not been based on any common agreement as to the capacity necessary. We recommend the establishment of consumption forecasts, periodically checked and revised, to serve as a guide for current production and for investment in plant facilities.

Until recently our rapid industrial growth created such ever mounting demand for minerals that in many cases the existence of an adequate market has been assumed, and attention has been centered mainly upon the finding and development of new deposits. Almost any mine sooner or later found an outlet for its product. Explorers, promoters, and their backers, as a class, have given very little attention to the possible limitation of the market for anything they might find or develop. Even the well-organized industries have been slow to realize that fundamental changes in demand are taking place.

The need of forecasts and the possibilities of basing them on past trends may be illustrated by production trends of the fuels and the major metals. For 2 or 3 decades preceding the war, consumption of all the principal minerals expanded rapidly—faster than the population—and it was a common belief that this expansion would continue indefinitely. This was a period during which many small mineral enterprises were consolidated into large units, and large capital was drawn in. Banks insisted on ample reserves of raw materials as a basis of financing. Holdings of reserves were sometimes augmented for trading purposes by companies contemplating merger. Manufacturers and distributors reached out for their own mineral supplies. As the commercial units grew larger, it became necessary to plan further ahead for capacity and reserves. The result was ever-increasing speed of exploration and development

After 1914 growth was further stimulated by the World War. The munitions demand affected nearly all the minerals, and some were further boomed by the blockade of major sources of supply outside the United States. In many industries the war led to a huge increase of capacity, especially in zinc, copper, and bituminous coal.

After the Armistice, the industries which had been most stimulated by the war experienced a sharp reaction. The high prices of 1916–18 had brought on other changes beside expansion of capacity, such as substitution and economies in use. In iron ore, anthracite, and bituminous coal, for example, production has never again equaled the war peak. In copper, the smelter output from domestic ores did not regain the war level until 1929. Yet in many cases, the expectations of mining men continued to center on a projection of the pre-war curve. Thus in iron, the overdevelopment of mine capacity, which in some way must now be liquidated, is fairly measured by the gap between the projected pre-war trend and the actual trend. There were, of course, many other minerals, such as oil, natural gas, and sulphur, the demand for which continued to grow by leaps and bounds up to the coming of the great depression. In fact, the great majority of the domestic mineral industries established new peaks of production in the years 1926–30. Yet the experience of iron, coal, and copper suggests that a gradual flattening of consumption curves is to be looked for by other mineral industries, even on return of normal business. Few subjects are of greater importance to any industry than the future of consumption.

No attempt will be made here to analyze all of the reasons for such changes in demand. Their existence only is emphasized. Study of industries concerned shows many detailed causes for these changes—technological advances, more efficient utilization, increasing use of scrap, changing habits of consumption, approaching saturation or decline in the demand for certain industrial products, slowing down of the acceleration of population growth, and other factors. All of these elements are capable of analysis in forecasting of trends. The flattening of production curves is not a special case applying to minerals alone, nor is it merely a temporary change due to the depression. Many other economic and social phenomena show a similar tendency toward retardation of earlier rates of growth.

General recognition of this fact by the industries affected has been very slow. Even yet the fundamental change in conditions is not everywhere recognized. The old psychology of indefinite expansion persists. There have been such wide fluctuations in annual demand over the last 20 years as to obscure the general trend, making it easy to assume that each year was abnormal and that in time consumption would

come back to a scale indicated by the projection of the rapidly rising pre-war curve of mineral demand.

Far-sighted leaders of these industries, however, are awake to the need of forecasting consumption in the light of the changing conditions. Long-time forecasts are needed for such light as can be thrown on the problems of planning investment in plant capacity. Short-time forecasts are essential in the effort to balance current production with market needs. The value of such forecasts has been seen for some time, but up to the present collective action by the industries has been handicapped by the fear that it might be construed as conspiracy in restraint of trade under the antitrust law, by the lack of authority to secure comprehensive data, and by doubts as to the accuracy of some of the figures furnished by interested parties. Furthermore, estimates made by producers have on the whole lacked the check of similar estimates from the side of the consumers, who alone were in position to supply some of the data essential to the analysis.

In the opinion of your committee forecasts of mineral consumption are a proper function of Government. A Government agency with power to require reports, working in friendly cooperation with the mineral industries through their trade institutes, and wherever possible with consumer organizations, or purchasing associations, would be able to secure complete figures from all sources. It is obvious that a record of consumption is essential to such a forecast. Individual returns should be held confidential, but the final estimates should be reviewed jointly by the Government agency in conference with representatives of producer and consumer organizations. Under this arrangement, the participation of the Government would insure freedom from bias, and the presence of business men representing both sides of the market would add confidence in the reliability of the forecasts. The estimates would command attention and respect, not only from industry but from that part of the general public which occasionally speculates in mineral development.

Oil is the only mineral for which the Government has thus far attempted such forecasts, and the experience with that commodity, starting with estimates by the Federal Oil Conservation Board in 1930 and continued under the present Petroleum Administrative Board, seems to demonstrate the feasibility of Government estimates for other minerals. There is general testimony from the oil industry that the inauguration of these estimates constituted a very important step toward conservation. While production has often overshot the mark thus set up, a definite objective has been in view for the first time, and it has served as a guide for all of the efforts to balance production and consumption that have since been made by the industry, by the States, and by the Federal Government.

Your committee recommends the regular issuance of similar forecasts of the demand for coal, copper, lead, and zinc. These are the minerals, in addition to oil, which are most afflicted with troubles of surplus, and consumption estimates are a first and immediate requirement in any attempt to balance production with consumption. For other minerals the need of forecasts seems less urgent, but as circumstances require, these also should be covered. Even without measures for production control, we believe that widely known official forecasts will go far toward discouraging unwise expansion of capacity, as financial support for new enterprises in fields already overdeveloped would be more difficult to obtain.

The committee is aware that all forecasting necessarily involves an element of hazard. Short-time forecasts are obviously much affected by the business cycle, by the export market, and (in the case of fuels) by the weather. Long-time forecasts are dependent on the future of business, on technologic change, and many special factors. Any forecast, therefore, should state the assumptions on which it is based and the range of probable error, and should be revised periodically in the light of changing conditions. As industries mature, their characteristic growth trends become clearer, and even in long-range forecasts it seems possible to indicate upper limits not for particular years but for periods of the length involved in planning large-scale capital investments. Responsibility for decision remains with the individual executive, but we believe his decision will be wiser if made in the light of the collective judgment of trade experts and a Government agency studying all the facts.

The proper agency for this work would seem to be the Bureau of Mines working in cooperation with the Geological Survey and Bureau of Foreign and Domestic Commerce. These agencies already have experienced personnel and much of the necessary information, and at comparatively small expense could build up staffs and records to undertake the task.

SECTION II

III. CONSERVATIONAL PROBLEMS ARISING FROM SURPLUS OF PRODUCTION OR PLANT CAPACITY

1. Conservation and Production Control

Foremost among the problems of conservation is the prevention of resource waste and associated social and economic disorder caused by the destructive competition characteristic of those minerals with a surplus of plant capacity or production. It may seem a paradox but it is a fact that resource loss is most serious in the same industries, such as coal and oil, where attention at the moment is centered on the disposal of an embarrassing surplus. In this group the problem of conservation is less one of technology than of economics. The task before the Nation is to help these industries to prevent competitive waste, bring supply in balance with requirements, stabilize employment, limit cutthroat competition, and by achieving some measure of stability, permit the savings in the underlying resource which technology has already shown to be possible. It involves considering the control of production, of capacity, of stocks, and often of price by methods which traditionally have been thought forbidden by the antitrust laws. It involves recognition of the competition between mineral industries, as in the fuel and power group, as well as within them.

While it is clearly inadvisable to authorize price-fixing and limitation of output in the great majority of our industries, such as general manufacturing and trade, it may prove to be wise, under the necessary public supervision, in those industries involving natural resource waste. Even during the present emergency, the N. R. A. has recognized a distinction between business in general and industries involving a problem in conservation. The Nation must learn that in some circumstances competition leads to waste that we can ill afford.

A review of the mineral industries shows that troubles of surplus are widespread, but most acute in coal and oil. They are present, though less acute, in iron, copper, lead, and zinc.

While there has been large overdevelopment of iron ore capacity, there has been no difficulty in holding production reasonably in line with consumption or in stabilizing prices, because of the fact that nearly all of the mines are captive and also because of the concentration of ownership in a few companies. These companies will take a large loss, because their overestimates of future demand have led to a great excess of mine capacity. However, it is not apparent that Government cooperation is needed to effect conservation of the resources, though it may be needed for rehabilitation of unemployed workers and safeguarding the welfare of labor. Problems of the type involved in the concentrated ownership of the mines are discussed in section II, V.

For the other five—coal, oil, copper, lead, and zinc—experience has thus far shown that the industries acting alone have been unable to prevent dissipation of resources or economic and social distress. Already, under the National Industrial Recovery Act, several of these industries are asking Government approval of various measures designed to stabilize supply and price, to control excessive stocks, or otherwise to set bounds to competition. Their leaders desire to continue the effort at stabilization in some form, and it is in the public interest to encourage them to do so. Each of the five listed has its own distinctive problems, sharply differing from those of the others, but all present in some degree the common problem of control of destructive competition.

2. Bituminous Coal [1]

Need for Stabilization: The mineral fuels are subject to a high degree of substitution and inter-industry competition. The bituminous-coal industry, as the oldest and most important source of energy, has suffered loss of markets to oil, natural gas, and water power. Competition within the industry has always been intense because of the widely scattered reserves and the thousands of producing units. Rivalries between districts and the legal obstacles of the antitrust laws have hitherto prevented any form of centralized organization.

Lack of adequate profits has meant inadequate wages and excessive waste of coal resources. For years the industry has worked in surroundings of poverty. Coal was therefore one of the industries which could gain the most from the facilities for collective action offered by the National Industrial Recovery Act. Its experience under the Bituminous Coal Code indicates that continuation of some form of price or production control is necessary to effect the stabilization of this industry.

Stabilization of the coal industry is needed to protect capital. In 1929, according to the Treasury Statistics of Income, there were 1,437 bituminous-coal companies,

[1] The statements in this section refer only to the mining of bituminous coal. The mining of Pennsylvania anthracite is a separate industry, not here considered. The retail coal business is outside the terms of reference of this committee

producing approximately 46 percent of the total output, that operated at a loss, and their deficits exceeded the income of the companies making a profit, so that the industry as a whole reported a net loss even during that year of boom. Virtually no other business covered by the Treasury's record showed such widespread money losses as the mining of bituminous coal.

Stabilization of the industry is needed to protect wage standards. The pressure of low prices upon wages in coal mining is direct and cruel. Whereas in manufacturing wages constitute 23 percent of the cost of the product, in coal mining they make up 65 percent. Any savings the operator can make in supplies, in power, in overhead, look small in comparison with the wage cost, and the pressure to reduce wages in periods of low prices is almost irresistible. Hence arises on the part of the mine workers the insistent demand for collective bargaining. Fifty years of bitter experience has proved beyond question that underlying the turbulent history of labor relations in this industry is the competitive pressure which often made it difficult or impossible for the employer to pay a decent wage or earn a profit. The record of the years from the end of the Jacksonville wage agreement to the signing of the N. R. A. code (from 1927 to 1933) is proof of the depths to which wage cutting can go, and unless some means is found by which a reasonable margin of profit can be assured in the future, resistance to trade unionism can be expected to return as before, and maintenance of any such wage structure as is developed by the code will become impossible.

Stabilization of the coal industry is needed to minimize waste of the resource.

In western Europe the average loss of coal in the mining of the beds now worked is from 5 to 10 percent. In the United States, according to careful field studies in 1923 by engineers of the Bureau of Mines and the United States Coal Commission, the average loss is 35 percent. Of this loss, 15 percent was considered unavoidable and 20 percent as avoidable, using the standards of engineering already shown to be feasible by the practice of the better companies. This meant that the avoidable loss amounted to 150 million tons a year, left behind under conditions that virtually prevent its being recovered.[2] That is coal enough to supply the entire requirements of the German Reich. In terms of energy it is equivalent to twice the production of natural gas in the United States. Conditions have since grown worse. Howard N. Eavenson, now president of the American Institute of Mining and Metallurgical Engineers, testifying in the Appalachian Coals case (August 1932) stated:

> The depressed condition in the coal business has had a great deal of effect on the waste in the mining of coal. Since the depressed condition of the last 7 or 8 years, a good many mines [that is, in Appalachian territory—a region where normally the recovery is relatively high] have found that it is very much cheaper for them to lose a very considerable proportion of the coal in the ground than it is to try to mine it. In other words, instead of recovering 85 percent or more, a number of them have gone to a practice where they will not get ultimately more than from 60 to 65 percent, because the ultimate result is cheaper than if they tried to mine the greater amount of coal. I think I could make the broad assertion that there is not a single bituminous mine in the country today that is not mining the very best coal that it has, and the cheapest, and is allowing portions of the mine to get into shape where a lot of the coal will never be recovered, because they cannot afford, at present prices, to mine it.

According to Newell G. Alford, from 1923 to 1932 a total of 4,802 bituminous mines were shut down or abandoned.[3] Some of these were worked out, but unfortunately, exhaustion accounted for but a small percentage of the mortality. The great majority of these old pits are not likely to be reopened. The quantity of coal lost in these old workings through collapse of roof, crushing of pillars and stumps, or through permanent isolation of odd acreages of unmined coal is unknown but must certainly run into some hundreds of millions of tons. Were these mines located in Belgium the loss would be regarded as a national calamity.

In the United States we are prone to ignore the loss in mining because coal seems so abundant, but the facts are that while our reserves of lignite and low-grade bituminous are indeed enormous we are exhausting our best bituminous coals at a rate that makes their conservation a serious national problem. For example, with production at the 1929 rate, the life of the magnificent Pittsburgh bed in Pennsylvania is limited to a hundred years, and the high-grade portions of the seam in the gas and coking coal districts will be gone long before that.

In the famous smokeless fields of southern West Virginia, the reserves in beds of commercial thickness are placed by Eavenson at 4.8 billion tons, which, at the 1929 rate of production, would last but 85 years. The same authority states that the highest grade gas and metallurgical coals are 11 percent exhausted in Kentucky and 22 percent exhausted in southern West Virginia and Virginia. Yet these coals, the Pittsburgh bed in Pennsylvania and the southern low- and high-volatile metallurgical coals, are the foundation of the American steel industry and their depletion will handicap not only steel itself but all industries depending on steel.

[2] George S. Rice and J. W. Paul. Amount and Nature of Losses in Mining of Bituminous Coal. *Report of the United States Coal Commission*, pp. 1855–1858.

[3] Alford's study included some wagon mines, but on the other hand, it did not cover Ohio or the trans-Mississippi fields. The total shut-down was therefore even greater than the figure quoted. Transactions of the American Institute of Mining and Metallurgical Engineers, vol. 108 pp. 476–488

The causes of the excessive waste attending the mining of our coals are complex, but the great underlying cause is destructive competition. The losses are nobody's fault in particular, for the individual operator is driven by economic pressure. In many cases the prevention of loss, while entirely possible from the point of view of engineering, involves a substantial increase in cost. Thus, in portions of the Middle West the removal of pillars would result in damage to the surface. In such cases it may be many years before a change in present practice is possible. But there remain many other losses which can be avoided with slight additional expense as the practice of the better companies in normal times has already shown. Prevention of such losses depends on relieving the conditions of poverty which have surrounded the industry. The members of this committee who have given most thought to the question are convinced that the necessary first step in reducing the waste of coal in mining is to aid the industry in establishing itself on a stable and profitable basis.

Experience has shown that a reasonable margin of profit stimulates conservation. The more valuable coal becomes, the more men tend to save it. (It is true that if wage rates advance more than prices, reducing the operator's margin, the effect may be anticonservational.) A financially stable company can afford competent engineers and adequate supervision: that is an important factor, since large tonnages are lost in squeezes due simply to lack of engineering control. It is known, for example, that the captive mines, freed from the extreme pressure of competition, generally secure higher extraction than the average commercial mine in the same district.

Reduction in waste may also be expected from other results of a program of production control. A check upon new development will prevent the premature abandonment of mines before they are worked out, thereby eliminating in the future losses such as those resulting from the closing of the 4,802 mines above referred to. With some check on the expansion of capacity, steadier operation of the mines remaining will ensue, thereby increasing the percentage of extraction. It is well known that recovery of pillars depends on maintenance of a regular breakline and a systematic schedule of operations, and some part of the present waste is due to the simple fact of irregular and intermittent operation.

Moreover, if reasonable prices are made possible, the coal industry may be asked to give assurance of reducing the waste. It would, for example, be possible for an N. R. A. code authority to study the problem and set up a local technical committee on conservation in each of the mining districts, charged with the duty of formulating reasonable standards of extraction as indicated by the better practice attained in that district. Such standards could then be recommended to landowners for incorporation in coal leases, to the mine inspection and conservation departments of the States, and to individual operators for adoption by their engineering staffs.

In time, if the industry can be placed on a stable basis and competition between districts held within reasonable bounds, the legislatures of the coal-mining States may be expected to enact conservation laws to lessen waste of their coal resources analogous to those already adopted in some jurisdictions for oil and gas. Hitherto, State action has been impossible, because of cut-throat competition. Progress in this direction can go no faster than development of a strong opinion within the principal coal States. Meantime, the first and indispensable step is so to organize the economic forces of the industry as to relieve the extreme pressure of competition.

These considerations, the exceptional money losses of operators, the protection of wage standards of a depressed group of workers, and the prevention of resource waste justify governmental aid in the effort toward stability which the industry alone is unable to accomplish.

Stabilizing Effect of Price Control Under the N. R. A. Code: In the case of bituminous coal, the N. R. A. code authorizes the direct control of prices. The choice of the minimum price as the instrument of control in the code was dictated by market mechanics and industry psychology. Had the framers of the code attempted to set up a system of rigid production quotas, they would have become involved in a welter of conflicting interests and local controversies. Centering attention on the direct control of price, they were able to formulate a code which won acceptance by all important districts and which could be put in operation at once. Aside from the labor clauses, price control is the central idea of the code. The code authority in each district sets the minimum price for every grade of coal mined in the district, and except as modified by the Administrator the price is binding on all shippers in the district. Under present conditions the minimum price also becomes the maximum price, in nearly all cases, since competition prevents the shipper from obtaining more than the minimum.

Despite numerous criticisms, the code has achieved a great measure of success. Criticisms of delay on the one hand and of over-hasty action on the other are natural in so new and so large an undertaking. Complaints of discrimination are heard from individual producers. Correlating price differentials between competing districts has proved difficult. Evasions threaten to reach grave proportions unless the power

to force compliance is upheld by the courts. Yet in comparison with the competitive chaos which preceded it, the code is a great achievement. For the first time in years prices have generally been held above production costs. Employers, now able to pay the agreed-on wage, have taken a different view of labor relations. Wage standards and working conditions in the East and South are better than for years past. This has been accomplished without unreasonable burdening of the consumer or serious curtailment of demand. Opinion in so large an industry is always divided, yet it is generally agreed that many features of the code should be continued. It is clear, therefore, that nothing should be done to handicap administration of the present code and that the experience gained under the code should guide any future attempt to adjust supply and demand in this industry.

The Case for Continuing Control: In the bituminous coal industry the outlook is not for a temporary emergency but rather for a long period of destructive competition and natural resource waste unless some continuing adjustment of supply and demand can be effected. In this industry the disadvantages of price and production control are less weighty, and they are offset by the public interest in conservation and in protecting the wage standards of the miners.

The problem of protecting the consumer against unreasonable advance in price is simplified in coal mining by the pressure of competitive sources of energy—oil, gas, and water power—and by the alternative offered to the larger consumers of opening mines for their own use. Industrial consumers already supply a fourth of their own requirements from mines which they control.

The objection that stabilization protects the inefficient producer loses some of its force in this industry where several thousand marginal producers (commercial mines, not wagon mines) had already been forced out of business before the great depression began. Any mine able to survive the years 1930 to 1932 has demonstrated a considerable efficiency. With deflation of the less efficient mines so far accomplished, the present time offers a unique opportunity to inaugurate production control.

The most serious objection to continued price control is the tendency under it to create more capacity, through development of new mines or reopening of old ones. There seems no answer to this objection short of providing some method of controlling the expansion of capacity, if permanent stability is to be attained.

Opinion in the coal industry is definitely in favor of continuing some form of price or output control after the expiration of the present code.[4]

Possible Forms of Price and Output Control: The minimum price concept of the present N. R. A. code and the tonnage quota concept developed first in Germany, tried later in England, and now proposed in many quarters for the United States, both have their strong points and their weaknesses, and both deserve consideration in any permanent scheme of control. Thus, foreign experience makes use of both price and tonnage control, and while the American code began with the simpler idea of minimum prices, it shows some signs of moving in the direction of quotas. There are, however, grave difficulties on the American scene which would make the quota plan much harder to operate here than abroad. One of the most serious is the difficulty of applying a national system of quotas to the intrastate shipments which in some fields make up a large part of the business. The choice of method is a highly technical problem to be worked out step by step on the basis of experience by the code administration in counsel with the industry. From the consumers' viewpoint, the choice makes little difference, for any minimum price that is observed necessarily affects the tonnage and, conversely, any tonnage limitation necessarily affects the price.

Even should it be found impractical to set up a uniform national system of prices or quotas, it would be possible to authorize price or production control schemes in the several districts, to be operated through district sales agencies or other local associations, subject to coordination by a central public authority. In any case, a large measure of district flexibility is necessary to meet the great diversity of local problems characteristic of this industry.

Necessary Safeguards: Any plan for stabilization of production and price must provide ample safeguards for the welfare of labor and the consumer. The question of safeguards necessary to protect the rights and liberties of the mine workers is a special subject of great importance, which will no doubt be considered by other agencies of the Government and is outside the particular province of this committee. The issue of consumer safeguards requires, in our view, (1) complete and uniform records of costs, prices, profits, and margins, and (2) review of any scheme of price or production control by a public authority clothed with ample powers. If the producer is to be protected by minimum prices, the consumer may reasonably ask to be protected by maximum prices. No such interference with free competition as is proposed by the coal industry is conceivable without such safeguards, both because the public would rightly withhold its consent and because the powers of Government are necessary to prevent a small minority of firms from paralyzing the action of the majority, as the experience of the present code so clearly shows.

Possible Forms of Capacity Control: Already the industry is awaking to the fact that control of price or output is not enough and that it must also grapple

[4] See Report of Special Legislative Committee of the National Coal Association, Oct. 27, 1934.

with the control of capacity.[5] Coal mining was overdeveloped 20, 40, or even 50 years ago. In 1929 the bituminous coal industry was burdened with a huge surplus of plant capacity due to many causes and not simply to the World War. The excess capacity has been a prime factor in the cut-throat competition, the resource waste, the financial losses, the low wages, and the turbulent labor relations. The problem of capacity before the industry is two-fold—first, to reduce the present surplus and, second, to control unwise expansion in the future so as to prevent a repetition of past overdevelopment. The necessity of some check upon future expansion is suggested by the increase in small truck mines which has already taken place under the code.

The Committee has considered some of the chief suggestions that have been offered for control of capacity.

It has been proposed at times that a sliding wage scale or a guaranty of minimum employment be included in wage agreements between operators and the miners' union, in a way to encourage a shift of business from high-cost mines to those able to operate more steadily.

It has been proposed that promoters of additional mines—as distinct from replacement of worked-out mines—be required by the Federal Securities Commission to include a full statement showing that existing capacity in the industry is already more than sufficient in all proffers of securities addressed to the investing public. Such a plan should discourage some unwise promotions. A similar provision is already in effect as to public lands through an order of the Secretary of the Interior that the offering of coal lands for lease or granting of prospecting permits be recommended only on reliable information that there is an actual need for coal which cannot otherwise be reasonably met.

It has been suggested that extensions of common carrier railroads serving the coal fields should be controlled in the light of their effects on mine capacity. Under the Transportation Act a railroad desiring to construct a branch line must obtain a certificate of public convenience and necessity, and if the central coal authority found that existing capacity was sufficient and recommended against the extension, the Interstate Commerce Commission might withhold its approval. This would not prevent promoters of a new venture from building their own branch line down to the railroad and demanding a connection, but it should serve to discourage unwise development. It would obviously have no effect on the increasing number of mines served by motor trucks.

It has been suggested that marginal mines be purchased by a governmental agency and shut down, a small tonnage tax being levied to pay the cost of the acquisition and to pay for rehabilitating displaced miners. Such a plan should do much to relieve the condition of the mine workers. It would afford steadier employment in the other mines remaining and would tend to center production in the lower-cost mines whose savings in overhead through steadier running time would go far to absorb the tax. This plan deserves most careful consideration, though its execution would have to be timed with reference to general relief and unemployment policies, so as to give reasonable assurance that workers discharged by shutting down the mines in question could actually be placed in other occupations. In further support of this plan, it is argued that where employment of coal miners is reduced by public hydroelectric projects, an obligation rests upon the public to rehabilitate the workers displaced.

It has further been suggested that such a tax be used to purchase reserve coal lands accessible to existing railroads and available for immediate development, these lands to be held as a national coal reserve and later leased as needed for payment of royalty to the United States. This plan accords with the Mineral Leasing Act of 1920, by which coal deposits on the western public domain no longer pass with the surface title but are leased under royalty. The plan provides a market for coal lands, thereby relieving the pressure on land owners to open more mines in order to meet taxes and interest, which, it is well known, has always been one of the most powerful causes forcing overdevelopment. To make the plan workable it would also be necessary for operating companies remaining in business to agree not to expand their own capacity beyond limits approved by the central authority. Possibly this could be done by contract or by code agreement. If such agreement to control the expansion of capacity of operating companies is provided, the plan for a national coal reserve deserves most careful consideraton. In this form it resembles the national forest reserves.

From this sketch of some of the proposals to deal with surplus mine capacity, it will be obvious that the problem is not simple and that any plan to be tried would require most careful study of its economic, technical, and legal features. Nevertheless, it may well be that the adoption of some of the steps here outlined or of other measures could prevent serious future inflation of capacity and its train of evils.

The committee, therefore, would commend the importance of capacity control alike to the industry, the mine workers, and the Government. We would urge the industry to remember that some limitations on the individual are necessary in any form of joint action. We would urge upon the public the great importance of the ends in view and feel that a friendly hearing should be accorded to any serious attempt by this

[5] Report of Special Legislative Committee, National Coal Association, Oct 27, 1934. "As a permanent basis for a sound recovery in this industry some control of overexpansion of productive facilities should be established."

industry to stabilize production and capacity on a national scale. Above all, we would counsel against a defeatist attitude. We cannot believe but that if the bituminous coal industry really desires to achieve economic stability there will be found both economic devices and constitutional powers sufficient for the purpose.

3. Petroleum

The Importance of Petroleum in National Economy: In this power age, petroleum is of paramount importance to our national welfare and security. The automobile, airplane, and oil-burning ship have become modern necessities. Liquid fuel to propel them and oil for their lubrication are indispensable. Consumers have an estimated investment of $15,000,000,000 in automobiles alone, and a $12,000,000,000 industry has been built up for the production, refining, and marketing of petroleum and its products.

The United States produces and consumes more oil than all other countries combined. During the past 75 years the United States has produced and consumed about two-thirds of the total world production of oil, although its share of the world's reserves probably did not exceed one-fifth. Proved reserves never have been sufficient to supply our domestic needs for more than a decade or two, and because of the highly conjectural nature of estimates of the magnitude of unproved reserves, fears of an imminent shortage have arisen repeatedly. Such fears generally are allayed during periods of large flush production like that from east Texas, but the fact should not be overlooked that the periodic flooding of the market is due more to an excess of wells through which oil may reach the surface than to a superabundance of the reserves.

The Nation's Petroleum Reserves: At present (1934) the proved reserves of oil recoverable by usual methods of production are estimated to be about 13 billion barrels. These would last approximately 15 years at the 1933 rate of consumption. However, since some of the oil included in these reserves cannot be produced until 20 or 30 years hence (because of the decline in rate of production as a well grows older), a shortage during the coming 15-year period can be prevented only by discovery of new fields.[6]

New production to postpone the day of shortage will no doubt be found, but sooner or later the Nation's output of oil from wells will be insufficient to meet the demand. The United States is depleting its supply of oil at a more rapid rate than any other country that possesses oil reserves of major importance.

Petroleum accumulated in the rocks in times past only under certain special conditions. Geologists have blocked off the great regions where such conditions have never operated and defined with considerable accuracy those limited areas that offer promise of future discoveries. Therefore, though the Nation's petroleum reserves are large, they are exhaustible. Discoveries can not continue to replace depleted fields for an unlimited period of time.

As prospecting for oil and the development of productive areas progresses, whole regions are eliminated as sources of new major pools of petroleum. Many parts of the United States have been so thoroughly prospected and developed that there is no possibility of discoveries of any considerable magnitude. In other areas, where the oil horizon lies at greater depths, the possibility of new major discoveries near the surface have been eliminated, leaving only the deep horizons, which require larger expenditures for development and operation. To date, the discovery of new pools, required to keep production in step with demand, has been largely the result of prospecting in new territory and drilling to greater depths in areas that are producing. Potential areas in which major discoveries may be made are being reduced rapidly through such prospecting and development.

Substitutes for Petroleum.—Liquid fuels and lubricants similar to those from petroleum can be made from coal and oil shale, but the processes cannot as yet compete in the domestic market with petroleum produced from wells. Probably the Nation will turn to such substances when the supply of petroleum becomes inadequate. The shifting from crude oil to coals and shales as the raw materials for the production of liquid fuels and lubricating oils probably will be deferred until petroleum products materially increase in cost. The substitutes cannot now compete commercially. It has well been said that:

> A forward-looking national fuel policy would seek to delay the day of making gasoline from coal as long as possible, by reserving the higher value fuels of natural gas and petroleum for these uses that cannot be so efficiently met by the direct combustion of coal.
>
> * * * it is now proved that technical processes for making gasoline or motor-fuel substitutes from coal are available if and when a failing supply of petroleum requires this step. But the product will be made with the sacrifice of much more of the original fuel energy than is lost in making gasoline from petroleum. Furthermore, the cost of the gasoline to the consumer will be materially higher. The fact that gasoline can be made from coal is no reason for continuing our present wasteful exploitation of petroleum reserves.
>
> * * * oil shale is by no means the ready source of fuel in an emergency that it is often assumed to be. A long period of time would be required to make the fuel available, much labor would be required, and costs would be extremely high.[7]

Waste of Petroleum Resources: Serious losses of this indispensable, irreplaceable, limited resource, some of which were unavoidable under conditions that prevailed in the past, have accompanied development.

[6] See testimony and report of H. B. Soyster, U. S. Geological Survey, in Parts 1 and 2 of Petroleum Investigation Hearings before Subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, 73d Cong., on H. Res. 441

[7] Bureau of Mines chapter on substitutes for motor fuel in review of the petroleum industry in the United States, April 1934: Circular 11, U. S. Geological Survey, pp. 37-48.

Wasteful practices include (1) overcrowding of wells in flush-production areas and developing such fields more rapidly than the demand warrants; (2) operating oil wells with improper gas-oil ratios; (3) actual physical wastage at the surface of prodigious quantities of vitally important gas, resulting in lower ultimate recovery of oil from the reservoir; (4) underground losses, resulting from migration of oil and gas through defective wells, from productive strata to beds from which the fluids cannot be reclaimed, and also from invasion of water into the oil sand; (5) erection of excessive storage facilities above ground, resulting in needless expense and actual physical losses due to leakage, evaporation, and fire; (6) use of inefficient equipment, resulting in losses of oil, gas, reservoir energy, and, at times, loss of life; (7) consumption of distress oil, forced on the market by overrapid development, for purposes in which other fuels should be used; (8) flooding world markets with exports of distress oil; and (9) premature abandonment, as a result of demoralization of crude-oil prices, of thousands of small pumping wells; these, if allowed to continue to produce, would still yield a large aggregate of oil.

The most striking of measurable wastes is the blowing of gas into the air. Such gas is valuable as fuel, but it has another value that perhaps is more important. The expansion of gas as the pressure is reduced is one of the most important sources of the energy that drives oil to the well and through it to the surface. Under present competitive practices, much of the inherent value of gas as fuel is thrown away and inefficient use is made of its propulsive power.

In 12 years in California, the quantity of gas known to have been wasted was about one-third of that produced for commercial use, and in 1929 30, the heating value of gas wasted from the Kettleman Hills field was equivalent to the expected energy output at Boulder Dam during a like period. In the fifth report of the Federal Oil Conservation Board the statement is made that in the Oklahoma City field alone the wastage probably averaged 300,000,000 cubic feet of natural gas per day for 1931 and 1932. As this is written nearly 1,000,000,000 cubic feet of natural gas is being blown to the air daily in the Texas Panhandle. This is equivalent in heating value to 40,000 tons of coal.[8]

Reservoir Energy: It has been pointed out that waste of gas involves more than a loss of its value as fuel. As recently stated:

> Probably the most significant trend of thought in oil and gas production is the growing realization that a producing structure is to be looked upon not only as a reservoir of oil and gas, but also as a reservoir of energy. Such energy, if properly conserved and used, will move the hydrocarbon fluids to the well and through it to the surface, delaying the time when energy must be supplied from external sources through gas or air injection, artificial water drive, the pump, or other means.

The Need for Conservation: There is no intention here to present a picture of gloom. The limited nature of our petroleum reserves and the rapidity with which they are being depleted are not such as to require a hoarding of oil and gas for future generations; however, they do necessitate a sound policy of conservation. Neither is there intention to blame the petroleum industry for the shortcomings of the system under which the Nation's petroleum reserves have been developed and operated. Some wasteful practices have been followed until recently because engineering study had been lacking. Others that have been pursued during the entire history of the industry may be attributed to the conditions arising out of:

1. The fluid nature of petroleum and natural gas. Other minerals remain in place until removed by the owner of the land in which they occur, or upon his authority. Oil and gas (and water) are unique, in that they will flow toward a region of lower pressure, in utter disregard of property lines.

2. The law of capture, under which ownership of oil and gas is established only by their actual reduction to possession at the surface. Under the leasing system, a lessee often is required to drill to retain his rights, even though he has no need for additional well capacity, and to produce in order that the lessor may receive royalty, although the market already is flooded with oil.

3. The fear, until recently, of prosecution under antitrust laws, which made individuals and corporations reluctant to enter into agreements for voluntary control of production.

Valid arguments may be advanced in favor of the law of capture, and the antitrust laws, but the fact remains that their combined effect, together with that of the fluid nature of oil and gas, has been anticonservational. The tendency of the law of capture has been to induce each owner of an oil-bearing property to withdraw the oil as rapidly as he could, regardless of the market demand, in order to prevent drainage by a neighbor, and the tendency of the antitrust laws has been to prevent pooling of interests, by which the effects of the law of capture could be nullified or ameliorated. With such methods of production, waste of gas and heavy loss in the ultimate yield of oil are inevtiable.

Control Measures: Recognizing the need for more effective conservation of the Nation's oil and gas and for the balancing of supply and demand, the petroleum industry, the various oil-producing States, and the Federal Government, have been endeavoring to find some type of control that would accomplish the desired ends.

[8] Hearings on petroleum investigations before a subcommittee of the Committee on Interstate and Foreign Commerce, House of Representatives, 73d Cong., on H. Res. 441, pt. 1, p 48

Fear of an impending shortage of petroleum, especially in California, instituted serious thought toward conservation early in the twenties, leading to the creation of the Federal Oil Conservation Board in 1924. This board and the American Petroleum Institute attempted to work out a program but before the support of the industry could be fully enlisted the country was drowned in floods of oil resulting from the competitive development of several pools of major size discovered in rapid succession. Industry was helpless in the confusion which each discovery caused, demoralizing markets and resulting in tremendous physical and economic waste of oil and gas. Meanwhile, many oil-producing States had accomplished much in the way of lessening physical waste by enacting statutes directed toward conservation of oil and gas.

Curtailment of production in the Seminole area, Oklahoma, in 1926 by voluntary agreement of operators, marked the beginning of the so-called "proration period." On August 9, 1927, the Corporation Commission of Oklahoma issued an order limiting production in the Greater Seminole area to 450,000 barrels a day and setting up a plan for allocation of that production to the different leases. Since then all newly discovered major fields in Oklahoma, and many other pools in the United States, have been developed under proration agreements or orders.

The first State-wide proration in Oklahoma was established under an order of the Corporation Commission dated September 8, 1928. In 1931 State quotas were enforced temporarily by martial law in Oklahoma and Texas. A report submitted by a witness at a recent Congressional Committee hearing stated:

> It cannot be said that proration has been entirely successful in curtailing production of oil to market demand. However, every thinking person in the oil industry knows, and the public should know, that under no circumstances can the market absorb the entire output capable of being produced from wells now drilled and in the process of being drilled, and that some form of curtailment either voluntary or compulsory is not only highly desirable, but necessary. * * *

Starting in 1930 a voluntary committee on petroleum economics, sponsored by the Federal Oil Conservation Board, made and published periodic short-term forecasts of the future demand for petroleum, for use by the industry. These proved to be remarkably accurate, and were of benefit to the industry in its attempt to achieve some degree of stabilization. About the same time, in 1931, the Secretary of the Interior proposed an interstate compact, later endorsed by the governors of Oklahoma, Kansas, and Texas, designed to bring some degree of order out of chaos but it was never placed in effect.

Voluntary unitization as a means of lessening the effects of the law of capture was partially successful over limited periods in certain areas, but often the dissenting small minority defeated the plans by draining oil from the field at the expense of the cooperating under the unitization agreement. Legal objections springing from the antitrust laws inhibited a serious attempt of the industry in 1929 to follow a plan of voluntary curtailment.

Success of the unit-development plan under a temporary act of Congress in the partly Government-owned North Dome of the Kettleman Hills oil field led to the passage in 1931 of permanent legislation authorizing the Secretary of the Interior to enter into unit or cooperative plans of development covering any oil or gas field on the public domain. Under the present policy known fields on Government lands will be unitized so far as practicable and future discoveries will be committed to unit operation in advance. Government policies, looking toward delay of production in time of surplus, account in part for the fact that although Government lands contain 15 percent of the country's proved reserves, they are supplying only 3 percent of the present output.

In 1932, in response to persistent demands by domestic producers, an excise tax was imposed on imported crude oil and refined products. This resulted in almost complete cessation of imports of light distillates and a considerable reduction in the importation of crude oil and heavy products. The law seemingly had little beneficial effect on the domestic situation, which went from bad to worse in the spring of 1933.

Finally under the Recovery Act the Government lent its hand, through section 9c of the act and the petroleum code, in an attempt to balance the oil supply with demand. Estimates of short-term future consumption, and allocation of production quotas to the producing States are made by an impartial Government agency. Attempts at enforcement have been made by both State and Federal agents, but only partial success has been achieved during the year in which the code has been in operation. Open defiance by small minorities, involving long court proceedings which have resulted in contradictory rulings, with a Supreme Court decision still in the future, has hampered effective control.

A bill to effectuate permanent Federal control over oil production failed of enactment in the spring of 1934, although provision was made for a thorough congressional investigation, now in progress, regarding the need for legislation of this type. Meanwhile, floods of "hot oil" from the East Texas field have seriously threatened to break down the oil code. As this is written, however, the situation is much improved through expeditious Federal action.

Conclusion: The extent to which our limited reserves of oil and gas are being drawn upon demands prompt adoption of a national policy that will insure a wiser and more efficient use of the remaining supply. Such a policy should have the following influences:

(1) To develop technical and scientific knowledge that will enable the operators of petroleum properties

to use energy associated with the oil for moving it to the well and through the well to the surface, leaving a maximum of energy in the system available to do such work in the future, thus minimizing the quantity of oil to be left underground beyond recovery by ordinary means.

(2) To discourage all forms of needless waste of oil and gas, and of the energy associated with them in their natural reservoirs.

(3) To discourage the drilling of more wells than conditions warrant.

(4) To prevent premature abandonment of small pumping ("stripper") wells.

(5) To encourage unitization of individual producing fields in order that geologic data and sound principles of engineering (rather than destructive competition arising out of property lines on the surface that bear no relation to conditions underground) may control the manner of their development and operation.

(6) While encouraging all proper and legitimate uses of oil and gas, to discourage production of distress oil, which demoralizes markets, leads to waste, and fosters inefficient or inferior use.

The movement toward production control is gaining impetus both within and without the industry, because regulation of output seems essential to a national policy that will promote the conservation of petroleum resources, the welfare of the industry, and ultimately of the consumers. The Congress, the Oil Administration and the several States are wrestling with the highly controversial question of methods.

In this report your committee makes no specific recommendations as to methods of control, but urgently recommends the development and effective application of a well-rounded plan to adjust the supply of petroleum and its products to demand, in a manner that will minimize waste of oil, gas and reservoir energy, and thus extend the life of our limited supplies. Such a plan should include:

(1) Methods of controlling supplies, involving regulation of domestic production, stocks, imports, and exports.

(2) Methods of controlling the development of fields discovered in the future. This involves orderly, rational drilling of the new fields in such a manner as to minimize waste and promote stability in the industry.

Unit development and operation of pools is the most effective antidote to the disastrous effects of the law of capture that thus far has been devised. The principles of unit operation now applied to most of the Federal lands should be extended, insofar as practicable, to those in State and private ownership.

The continuance and augmenting of a well-rounded Federal program of technical research to develop basic engineering information, and of Government estimates of demand, are necessary as prerequisites to any plan of control, present or future.

4. Copper

Turning now to the nonferrous metals, we find the desire of the industry to control competition less strong and the problem of conservation less acute than in the case of the mineral fuels. Yet here, also, there is waste of resources that is of national significance and that results in distressing economic losses. Considerations of labor welfare also point to the need of some modification of the rule of uncontrolled competition. A public as well as a private interest is clearly involved.

Emergency Control of Sales under the N. R. A. Code: Under the N. R. A. each producing unit in the copper industry is allocated a pro rata share of the available business, the smaller producers being allowed at the moment a somewhat larger percentage of their capacity than the larger ones. The code is the product of prolonged effort to meet an exceedingly difficult situation. The only compelling basis of agreement was the realization that something had to be done. The Government's immediate concern was to maintain, as far as possible, employment and to prevent the forced closing of mines by assuring each producing interest an outlet for some part of its production. The code, as approved, is the result of prolonged negotiation in which the producers were unable fully to agree. It represents the Government's endeavor to reconcile conflicting viewpoints and, though not accepted voluntarily in the technical sense, it seems to be regarded by the industry as preferable to the preceding confusion. Despite frequent criticisms we believe that majority opinion in the copper industry would not favor abandoning the code.

Moreover, it appears that the emergency prompting the code will not be over by June 1935. Demand for copper is dependent on revival of the capital goods industries, and consumption is still very low. There is a huge surplus of productive capacity. The mines have a capacity, conservatively estimated, of 1,000,000 tons of metal per year, against which mine production in 1933 was 195,000 tons, or less than 20 percent. In Michigan, Montana, and others of our most famous districts, the mines are now so deep or the ores remaining, so low in grade that they are quite unable to compete with certain of the newer fields abroad, not to mention lower-cost districts of the United States. Not least important, is the fact that enormous stocks of the metal have accumulated, which impede resumption of mining. At the end of 1933 the stocks on hand exceeded 600,000 tons, or more than enough to meet the

entire domestic demand for at least a year or, with allowance for expected return of scrap, enough for about 2 years. Employment in the industry is still tragically low, 16,000 men as against 65,000 in 1929, and protection of wage standards will remain a problem. It seems clear that continuation of some of the emergency features of the present code will be found necessary for a time after the expiration of the present Recovery Act.

Is There a Case for Long-time Control? How far it is wise to permit any long-time control of supply, assuming the return of general prosperity, we are not entirely sure. The copper industry has no background of experiment with production control, such as the petroleum industry has, to show either its advantages or drawbacks, as contrasted with unlimited competition. The domestic copper market is still interlocked with the foreign market; the problem of balancing supply and demand is fundamentally a world problem; and neither the copper industry nor the public have thought the problem through. Yet with copper, as with oil and coal, there are special considerations centering around the peculiar characteristics of mineral resources which suggest that the Nation must be prepared to consider some modification of the traditional regime of uncontrolled competition.

Economic stability is of peculiar importance to the nonferrous metals. They are especially subject to and they suffer from wide variations of price. They need, above all things, to balance supply and demand, to avoid needless expansion of capacity, and to temper the extremes of price fluctuation, whether sudden advances or violent declines. The quest for stability is seen in numerous foreign experiments, such as the European metal cartels, which have attempted, none too successfully, to control the extremes of competition.

Moreover, in the case of these metals, the consumer's objections to production control carry less weight than in the case of the typical manufacturing industry. The problem of protecting the public against unreasonable advances in price is simplified by the conditions of the copper market. International movements in a commodity selling at several cents a pound are extraordinarily fluid, and except for freight and tariff differentials, the price of copper is a world price. Competition from foreign sources is keen, so keen, in fact, that American copper producers have found it impossible to realize the full advantage of the import duty adopted in 1932. In the domestic field there remains a large reserve of high-cost capacity waiting for a chance to break into the market. Further, the consumer of copper has his own weapons. The scrap which he produces makes him a seller as well as a buyer of the metal. Copper is practically indestructible, and the total supply is cumulative. With minor exceptions, the fabricated product comes back in time for resmelting and reuse. In 1929 the recovery of scrap including copper in brass, was 404,000 tons, as compared with a new mine production of 998,000 tons. This salvaged copper (not including new scrap returned direct by fabricators) averaged 38 percent of the mine production from domestic ores in the years from 1924 to 1928, inclusive, 41 percent in 1929, and rose to 76 percent in 1932. An advance in the producer's price must reckon with this flood of scrap. Again the consumer has the alternative of substitution. In the field of power transmission copper meets competition from aluminum. In other fields it competes with this and other metals, including a rapidly growing group of alloy steels. All these factors work to protect the consumer against any unreasonable advance in copper prices to a degree far greater than is true of most lines of manufacture. Aside from the vexed question of tariff protection, the consumer should have little to fear from control of copper production, under reasonable safeguards of public supervision.

On the other hand, the consequences of uncontrolled competition are far more serious in copper than in general manufacturing. Violent price fluctuations lead to excess capacity. New mines are opened, extensions are projected into the lower grade ore bodies of existing mines, and the capacity thus created in response to the high price may be left high and dry before systematic extraction of the ore body is complete. In all industries such stranded capacity results in capital loss, but in copper it also involves peculiar hardships to the mine workers and waste of the resources. The depression coming on the heels of the boom times has left thousands of miners wholly dependent on the mines and with no prospect of local employment. Decline of old metal-mining camps is often inevitable, but social welfare demands that the hardships on the mining population be lessened wherever possible. In the desert camps the very water supply itself may disappear when the mine closes, and today the plight of the copper towns of Houghton, Hancock, Butte, Globe, and lesser camps is perhaps the hardest of any American communities. As the water creeps up in the Michigan mines, the community dies. Any effort to avoid recurrence of these conditions by cushioning these extreme fluctuations in price and production is clearly in the public interest.

Not least important, these fluctuations in price and output lead to serious waste of the resource. Mining efficiency and resource recovery require orderly and continuous operation and are handicapped by violent change in demand. Existing mines were laid out with a certain price level in mind and with a certain anticipated life. When prices collapse, the initial plan of

operation must all too often be discarded. Today mine operators are driven to neglect the most elementary work of maintenance. They are driven reluctantly to practice "selective mining"; that is, to take only the richest portions of the ore body, abandoning the attempt to recover the associated lower-grade material. This practice of gutting the mine or "picking the eyes out" reduces the average value of the ore left behind and at the same time increases future cost of recovering it, through caving and flooding of the workings. Again, mine owners are forced to take out the pillars previously left for support, when they contain bodies of high-grade ore, thereby allowing old stopes and levels to cave. As the shut-down continues, the damage grows progressively worse. Shafts and main haulage-ways collapse. Barren rock and ore are crushed and mixed together, making future separation difficult or impractical. In the great shrinkage stopes used in some mines waste rock mingles with the broken ore, diluting the metal content of the product and greatly increasing the cost. In Michigan and elsewhere mines are filling with water. The conditions cited are not imaginary. They are actually going on in many once famous mines, and taken together they act to endanger resumption of mining and to raise future costs. The increase in cost cannot be estimated closely. It depends on conditions and on the time that may elapse before attempting to resume production. But any mining man can visualize conditions where the unit cost of later reopening and recovering the rest of an abandoned ore body might be 50 percent, 100 percent, or 200 percent more than the cost if the same ore had been taken out in one continuous operation under the original plan of development. If the present shutdown of our copper mines continues for many years more, there will be huge tonnages of ore hitherto counted as 10-cent or 12-cent copper that will actually cost 15 cents or 17 cents.[9]

If the Nation could be sure that the price of copper would never rise above the present 9-cent level, there would be no cause for concern at the premature abandonment of those mines unable to produce at 9 cents. But the fact is that while America still has some of the lowest-cost mines in the world and while the life of these low-cost properties will run for many years, her total known reserves recoverable at 9 cents are placed at only 15,000,000 tons, which would meet the national requirements for barely 15 years at the 1927 rate of consumption. It is evident, therefore, that we can no more afford to waste our metal than our fuel. Indeed, copper is a clear example of the advancing depletion of the national resources. A large part of our original endowment is exhausted, and the centers of world production are shifting to Chile, Canada, and Africa, whose combined reserves now exceed our own in the ratio of four to one.[10]

In thus discussing the present plight of the domestic copper mines, we do not mean that the condition could have been prevented by a policy of price and production control. The surplus of capacity was primarily due to the World War. The high costs of the older districts reflect the steadily growing handicaps of nature, and the canyon-like drop in demand after 1929 was mainly caused by the World depression and loss of exports incident to the expansion of foreign capacity. But we are convinced that some more orderly control of supply and demand would have done much to check undue expansion and to cushion the fall. No small part of the present plight of the industry is due to the speculative boom of 1928–29, when prices which had hung for several years around 14 cents rose first to 18 cents and later, for one hectic fortnight, the metal was quoted at 24 cents a pound. The prices of 18 and 24 cents were very bad for the copper industry, and all people dependent on copper for a livelihood will be paying for the speculative excesses of that period for years to come.

It is now clear that the record demand of 1929 was in part artificial and forced. While the official statistics showed no great increase in the nominal stocks of producers, it is now known that fabricators affiliated with producer interests were accumulating an enormous stock, held largely for speculative purposes, and in some cases concealed from the rest of the trade. To make matters worse, in the fall of 1930 the copper industry stopped the monthly publication of stock figures. The policy of suppressing vital market information proved to be against the public interest and disastrous to the copper industry. Stocks continued to mount until the position became untenable. The swollen stocks have continued to hang over the industry; progress in reabsorbing them is very slow; and the necessity of reducing them acts to delay resumption of mining and employment.

At the same time the speculative boom of 1928–29 stimulated further expansion of capacity, not so much in the United States as in the foreign field. Foreign sources previously latent were actively developed. While capacity was thus increasing, demand, feeling the onset of the great depression, began to fall. A world surplus resulted, and in 1932 the higher-cost

[9] To remove half an ore body at one period and then come back years later to recover the other half is expensive and wasteful. Often it would be necessary to sink a new shaft and drive new levels. This means, first, that the capital costs are doubled by the piece-meal development, and, second, that the later development could be started only at much higher levels of price. For the second operator has only half as large an ore body to work on, and in order to break even, he must plan to charge twice as much per ton in order to amortize his initial expenditure. In this connection it should be noted that, while the general effect of violent fluctuations in price is clearly anti-conservational, a period of high prices does permit cleaning up some high-cost ore that would otherwise be abandoned.

[10] Reserves of metal must be measured by the price at which they can be produced Published statements of reserves of American producers indicate a total of 21,000,000 tons and of foreign producers of 83,000,000 tons, all in terms of metal that could be produced under past prices. These statements of reserves should be considered as a minimum rather than a maximum figure, though those of the United States are probably better known than those of foreign countries

American producers induced Congress to levy an import duty on foreign copper of 4 cents a pound. Sufficient time has not elapsed to evaluate accurately the effects of this act on American producers.

Recommendations as to Production Control: The committee is not prepared at this time to recommend either to the copper producers or to the public a copper cartel following the European plan, with full control of price, output, capacity, and other elements of supply. If such a system of control is to come in the United States, time must be allowed for experiment with less ambitious schemes and for development of a larger body of experience both in the technique of industry operation and of public supervision, under the very different conditions of American life.

But the committee would urge leaving the way open for experiment in these lines under public supervision and with provisions that will at once safeguard the rights of labor and clarify its responsibilities. We would urge that the problem of economic stability in the copper industry is essentially international and that joint action by American producers and foreign producers may often be needed. In the past this has sometimes been done indirectly through an export association operating under the Webb-Pomerene Act. In the future more direct collaboration will be necessary, and if adequate supervision by public authority is provided, such collaboration should be encouraged as in the public interest.

In addition, the committee offers the following recommendations.

(1) Full and complete statistics should be provided covering all factors of supply and demand, including consumption and consumers' stocks as well as production and producers' stocks, and including scrap as well as virgin metal. Such market information should be deposited with one of the permanent Government mineral fact-finding agencies. The basic data should be compiled in the form of totals or aggregates and published promptly for the use of both consumer and seller. The collection of such statistics should proceed with the closest cooperation of the trade organizations most interested.

(2) Forecasts of consumption should be made by a public agency in collaboration with representatives of both producers and consumers as outlined in section II.

(3) Some limitation should be imposed on the piling up of surplus stock. It is assumed that the emergency control under the present N. R. A. code will in time reduce stocks to manageable proportions. Thereafter we recommend limitation of stock accumulations by joint action of the trade, under supervision of public authority. If such joint action by the industry is forbidden by the anti-trust laws, we recommend consideration of such legislation as will authorize it under the necessary public supervision.

The justification of the proposal for cooperation between Government and the industry lies in the conservation of a resource under an orderly program of production, in encouraging a sounder financial policy for exploration and development, and in curbing promotion of unwise ventures. Also it should help to insure a fair profit return from the most economic operations, provide more stable employment and maintain wage standards, prevent the periodic dumping onto private charity or public relief of standard populations, and protect the consumer from unnecessary price fluctuation and from price manipulation.

5. Lead

Conditions in the other nonferrous metals are less acute than in copper, but here also the Committee finds the need of permitting joint action by the industry and Government to control some of the wastes of competition. In the lead industry the depression has greatly reduced consumption, but owing to the heavy cost of shutting down a mine it has proved difficult to make the necessary adjustment of output in an orderly way. Unmanageable stocks have accumulated, further delaying the resumption of mining. The situation has brought grave hardship to labor and waste of resources.

Present Position of the Industry: Demand for lead is still very low. The principal uses are for pigments, batteries, cable covers, ammunition, industrial alloys, and for special purposes in the building trades. Consumption, therefore, has felt the depression of the capital goods, automotive, and construction industries. Meantime, demand for new metal has been further curtailed by the returning stream of scrap, to which we have elsewhere referred, as well as by the keen competition of other metals.

Responding to these factors, production of new lead has fallen sharply. The mine output decreased from an average of 664,000 tons a year in 1925–29 to 273,000 tons in 1933, a decline of 59 percent. The average, however, does not show the full extent of the decline in some important districts. In the Western States lead is largely derived from complex ores and the by-products, especially the gold and silver, recovered afford a substantial credit. In Missouri and others of the Central States the gold and silver are absent or, at best, unimportant. As a result, the decline of production has been the greatest in the Central States, where 1933 output was 62 percent below the predepression level, against 57 percent in the West. Recent advances in

the prices of gold and silver have further increased the handicap of the central districts and increased the production of the complex ores of the West. This stimulus of byproduct gold and silver has added to the existing surplus of lead.

Drastic as the curtailment of mining operations has been, it was still insufficient to bring production in balance with demand and to prevent the accumulation of huge surplus stocks. Total stocks of refined lead in the United States increased from 103,000 tons at the end of 1930 to 176,000 tons at the end of 1932, 203,000 at the end of 1933, and to a peak of 241,000 at the end of July 1934. Since then stocks have been reduced slightly, but at the end of September there still remained 230,000 tons on hand, or more than twice the stocks of 1930 and equal to nearly 8 months' consumption at the rate prevailing in 1933. The excess suggests a pressing need for some measure of stock control.

These conditions have resulted in widespread distress in the communities dependent on lead mining and smelting. The number of men employed has dropped to barely half of the 1929 level, a decrease of 14,000 men. Meanwhile, the working time of those still on the rolls is diminished by the necessity of spreading the employment available.

As with copper, conditions are forcing selective mining, premature abandonment of mines, and loss of low-grade reserves. Though the losses in metal are less than in copper, the industry can ill afford them, for the known reserves of lead are small in terms of the national life. No new domestic lead deposits of major size have been discovered in two decades, though important extensions of known ore bodies have been reported. Maintenance of reserves has been accomplished by making low-grade deposits commercially available by means of improved technology and lower production costs. Both processes have gone so far that less marked improvement in this direction can be expected in the future. The present known reserves of lead in the United States are estimated at about 10,000,000 tons of the metal. This would only be equal to about 15 years' supply at the rate of mine production in 1929.

Recommendations as to Production Control: The Lead Industry Code approved by the N. R. A. set up no specific measures for the control of capacity or production. The industry's realization that some such step might be needed is shown by a provision that plans for the control of production through voluntary agreement, including stabilization of employment and conservation of lead resources, might be recommended to the Administrator.

Your committee feels that the lead industry will not be out of its difficulties when the present Recovery Act expires and that some means of permitting control where it may be needed might well be provided thereafter. Substantial improvement in this industry is dependent on revival of general business, and recovery of price to a level permitting a greater spread of profitable operation. Return of predepression prices cannot be expected, as the domestic price is controlled by the London price, plus a tariff differential, and recent expansion of capacity by low-cost producers abroad makes it probable that world prices will be lower than those formerly prevailing. In these circumstances, there is need for measures to control stock accumulation and to reduce the present surplus to manageable proportions. There may also be need for collaboration between American producers and foreign producers, and with suitable participation of a public agency, such collaboration is in the general interest.

As with copper, the committee concludes that the formulation of specific plans should originate with the industry. We would suggest for immediate consideration, however, (1) development of better statistics of secondary lead to supplement the market information services already available for this industry; (2) establishment of consumption forecasts, to be made by a Government agency, such as the Bureau of Mines, in cooperation with producers and organized consumers; and (3) joint action by the industry under public supervision to control the accumulation of excess stocks.

6. Zinc

The economic problems of the zinc industry have much in common with those of copper and lead. As with the companion metals of the nonferrous group, the United States is the world's largest producer and consumer of zinc, but the American industry has felt the weight of the depression more heavily than operators in other countries. The zinc industry has been more successful in avoiding the accumulation of excessive stocks than have copper and lead, but the adjustment has been accompanied by acute unemployment, stranded mining communities, and permanent loss of substantial quantities of low-grade ore.

Present Position of the Domestic Zinc Industry: In the predepression years the American zinc industry accounted for about 40 percent of the world's production and consumption. Its relative position has now changed, the output in 1933 having amounted to only 28 percent of the world total.

While few zinc deposits have been developed in the United States in the last decade, this is not true of the rest of the world. Large increases in capacity, either real or potential, have been made in Mexico, Canada, Spain, Yugoslavia, Australia, and elsewhere. The future price of zinc in world markets may, as a result, be expected to remain at low levels for some years.

The increase in production capacity abroad was reflected in lower prices as early as 1927. This led to the formation in 1928 of the European Zinc Cartel, an organization of producers operating outside the United States. While the Cartel was unable to stem the tide of deflation brought on by the world depression, it undoubtedly accomplished much good in providing a better balance between production and consumption. World stocks of zinc declined in 1932 and 1933 but the foreign situation was aggravated by depreciated currencies, imposition of tariffs, and maintenance of uneconomic production by Government subsidies.

In recent years our foreign trade in zinc has declined to small proportions. During the war a large export trade developed which reached a peak in 1917 when 218,000 tons of slab and sheet zinc were shipped abroad. This was equivalent to 33 percent of the total smelter output. Contemporaneously there was an increase in imports of zinc ore for treatment in domestic smelters. The maximum production of zinc from foreign ores was achieved in 1916 and amounted to 104,000 tons. The forced demand of the war period stimulated a huge expansion of mine and smelter capacity. After the war, our export trade in zinc sharply declined and since 1930 has been relatively unimportant. Imports of zinc ore have virtually ceased.

The metal is principally sold as slab zinc for galvanizing and brass manufacture and as sheet zinc. Pigments are made both from ore and from slab zinc. Competition is keen with copper and lead and with steel alloys. Use in galvanizing has declined but demand for zinc pigments has gained as compared with lead. The total available supply of zinc derived from ores and secondary sources in the United States decreased from 901,000 short tons in 1929 to 356,000 in 1932, but increased to 504,000 tons in 1933.

Since all of the zinc used for pigments and a large part of that for galvanizing is destroyed, the reclamation of zinc from old scrap is not so important a factor in relation to excess capacity as in the case of copper and lead. Such reclaimed zinc has amounted only to about 20 percent of new production in recent years.

At the end of 1928 stocks of zinc at primary reduction plants amounted to 47,000 tons. Beginning with July 1929 there was a constant and rapid increase in stocks which persisted until a peak of 167,000 tons was reached on December 31, 1930. During 1931 and 1932 there was a decline to 128,000 tons, but during the first half of 1933 there was a further increase which carried the total almost up to the previous peak. During the last half of 1933, however, there was a rapid decline owing to a sharp increase in consumption and at the end of the year stocks stood at 110,000 tons. About the same amount was on hand at the end of September 1934, despite enforced curtailment of output by the strike of the miners and millmen in the Butte district. Assuming 45,000 tons as the normal stock requirement, excess stocks at present represent less than 2 months' supply at the normal rate of consumption and less than 3 months' supply at the average rate in 1933.

Capacity of both mines and smelters is greatly in excess of requirements. The surplus is primarily the result of the World War, and even in 1929 mines and smelters operated far below capacity. In 1933 only one-third of the capacity of zinc retorts was utilized.

The principal mining region is the Joplin or Tri-State district at the junction of Missouri, Oklahoma, and Kansas. Next in importance is the Western States area, the principal contributors being Montana, Utah, Idaho, New Mexico, and Colorado. In the East there are important mines in New Jersey, Tennessee, Virginia, and New York. During the depression the Joplin district and the Western States have borne the major part of the curtailment. In 1933 the Joplin district produced only 44 percent of its 1929 output and a much smaller fraction of its capacity. At the trough of the depression, the district was producing hardly 20 percent of its peak.

The loss of metal resources induced by such violent fluctuations of production is nowhere better illustrated than in the zinc mines of the Tri-State district. The ore-bearing formation underlies a wide area, at relatively shallow depth, and ownership was originally scattered among several thousand farmers. These conditions have led to a great number of small-scale enterprises. Under the stimulus of high prices, especially during the war, hundreds of mines have been opened. In comparison with some other districts, the ore is relatively low-grade. It is essentially a one-crop resource, and if the crop is not well harvested, there is trouble in recovering it later. Miners may return to abandoned workings, but in general, the total cost of such piecemeal development is much higher than if economic conditions permitted systematic extraction in a single operation. Under the present low prices, the operator is compelled to leave far more of the marginal ore behind, though construction of large central concentrating plants will help future recovery by reduction of milling costs.

The possible loss of metal is increased by the water problem. The ore-bearing formation is honeycombed with old and new workings, and over large areas these openings are interconnected. Drainage from one mine into another, always a factor, has been greatly increased by the premature closing of mines forced by the depression. In certain areas all the mines are now flooded, and could be reclaimed only by cooperative action at heavy expense. The situation threatens to force abandonment of a large tonnage of low-grade material under conditions that would make its ultimate recovery possible, if at all, only at great increase in cost.

Were our reserves of zinc unlimited, the Nation might feel no cause for concern. The facts are quite otherwise. No great new fields have been discovered in the last 20 years, though reserves have been increased by important extensions of known areas. The maintenance of reserves has been accomplished chiefly by improvement of technology. The perfecting of the process of selective flotation between 1921 and 1925 added greatly to the domestic reserves by making lower-grade deposits commercially available. This process not only made possible the recovery of zinc from ores formerly considered unworkable but increased the percentage of metal obtained from many ores already worked. The invention of a process of recovering zinc from lead furnace slags has also been an important advance in the conservation of this resource. Yet in spite of these metallurgical achievements, the total reserves of zinc so far as now known are placed at only 11,000,000 tons, or about 15 years' supply at the 1929 rate of mine production. In these circumstances, the threatened loss of metal in the Tri-State district and elsewhere calls for cooperative action. Consolidation of mining companies and pooling of efforts to meet the water menace should be encouraged. There is also need of joint action by the industry to temper the extreme fluctuations of the market, thereby avoiding needless expansion in boom times and cushioning the decline in times of depression.

Production Control in the Zinc Industry: Provisions in the Zinc Code, now pending before the N. R. A., may result in the formulation by the industry of plans to control production, especially in the Tri-State area. As already indicated, some plan for the more orderly adjustment of supply to market needs is in the public interest. The committee believes that some authority to encourage the submission of such plans by the industry and to give the necessary approval and public supervision, should be continued after expiration of the Recovery Act. The need of cooperative action is likely to continue. Substantial improvement in the zinc industry depends upon the revival of general business and recovery of metal prices. A return to pre-depression prices probably cannot be expected, for the domestic price is controlled by the London price, plus a differential of about 1¼ cents, owing to the tariff, and excess productive capacity abroad makes low world prices probable for some years to come. It may prove wise to encourage collaboration of the American industry with the International Zinc Cartel under supervision of a public agency, in the way we have already sketched for copper.

As in the case of other nonferrous metals, the committee suggests for immediate consideration the issue of periodic forecasts of consumption. Such forecasts, made by an established Government agency in collaboration with operators and trade organizations, should be vitally useful in effecting a better balance of production and consumption. Joint action to limit the accumulation of excessive stocks may also be desirable, if the industry desires the cooperation of the Government to accomplish this end.

7. Conclusions as to Production And Capacity Control in The Mineral Industries

After careful study of the varying conditions in the coal, oil, copper, lead and zinc industries, and of certain others to which specific reference is not here made, the committee makes the following general recommendations for permissive control of production and capacity, where resource waste is shown to be serious, and where control offers hope of reducing the waste.

(1) The bituminous coal, oil, copper, and lead codes and the proposed zinc code, all contain provisions permitting the industry to control competition in one way or another, under Federal supervision. So far as controls have been used, the benefits seem to warrant continuance of some such provisions, after June 1935. For bituminous coal and oil, the case for permitting control is clear. For copper, lead, and zinc, the case is not so evident, but conditions are serious enough to warrant some modification of the rule of unlimited competition after the expiration of the National Industrial Recovery Act.

(2) While control of production and capacity by most industries is impracticable, except perhaps in emergencies, such control is in the public interest where destructive competition causes serious waste of an irreplaceable resource and endangers living standards of the mine workers, whose isolation, relative immobility, and hazardous life, merit special consideration. In the special case of coal mining provision for minimum and maximum prices may also be justified.

(3) This committee recommends the consideration of action by Congress empowering an appropriate agency, or agencies, where resource waste and depression of mine labor standards are found to be serious, to authorize systems for the control of output or capacity, or both of them, and where necessary, as in the case of coal mining, to authorize minimum and maximum prices, and to supervise the operation of such control. If necessary, the antitrust laws should be specially amended to permit such action. In framing such legislation due regard should be had for the competitive interrelations of coal, oil, gas, and water power and of the nonferrous metals.

(4) Authorization of any such system of control by the producers in an industry should be made contingent upon acceptance of whatever safeguards are deemed necessary by Congress to protect the mine workers and

the consuming public, and upon assurance by the industry concerned that action will be taken to minimize resource waste.

The question of labor safeguards is a special subject of great importance and involves a clarification of the responsibilities of the miners as well as protection of their rights and liberties. This subject will be considered by other agencies of the Government and is outside the special province of the committee.

Regarding consumer safeguards, the committee feels that when an industry asks for the privilege of limiting competition, the supervisory authority should be given power to prescribe forms of accounts, to require reports, and to modify, disapprove, and review the operation of any proposal for price, production, or capacity control. At the same time, producers in the industry may reasonably ask to be protected against any unfair practices of organized and powerful consumers.

(5) The committee makes no specific recommendations as to which agencies of the Government should be designated to administer the plan. The legislation necessary might take the form either of a separate act applicable to a single industry or of a general enabling act applicable to the natural resource industries as a group. In the case of bituminous coal and petroleum, it seems likely that separate acts might be preferred, to provide for special problems peculiar to these industries, such as the purchase of marginal mines, or the establishment of crude-oil quotas. In the case of copper, lead, zinc, etc., the general enabling act might be preferred, leaving each industry to avail itself of the act and propose a plan of control should conditions so require.

In view of the common problems of the mining industries, and in some cases of the competition between them, we would, however, urge the importance of centering administrative responsibility under the same general auspices. Conceivably this might be done under the Department of the Interior in order to effect the fullest use of that Department's fact-finding, scientific, and technical services, and to coordinate the operations of production control with administration of the public domain. Or conceivably it might be done under a permanent recovery administration in order to coordinate mining codes with other industry codes. Decision on this matter turns among other things on whether the present National Recovery Administration is to be continued in some form after June 1935. The important point is to provide a source of authority to be used when needed for price, production, and capacity control in industries involving waste of limited and irreplaceable resources.

(6) Experience under the N. R. A. codes has shown the importance of flexibility and administrative discretion. We suggest, therefore, that the choice of the particular method of control in a given case should be left to the administrative agency in council with the industry concerned, selecting from whatever methods may be authorized by Congress the ones best suited to the conditions of the industry. This would leave room for modification of the method of control in the light of experience and of judicial interpretation. A plan of control once approved, however, the powers of the administrative agency to require compliance should be made as clear and as complete as the constitutional powers of the Federal Government permit.

(7) In general we recommend the selection of methods which leave a considerable field of competition among producing units in order to avoid the artificial maintenance of high-cost marginal enterprises.

SECTION II

IV. CONSERVATIONAL PROBLEMS ARISING FROM DEFICIENCY OF DOMESTIC SUPPLY

There are outstanding deficiencies in domestic supplies of antimony, chromite, manganese, nickel, and tin. Partly inadequate are the supplies of mercury, tungsten, asbestos, barite, china clay, graphite, magnesite, mica, pyrites, talc, and soapstone. These lists include several important ferro-alloy minerals necessary for the manufacture of steel. While the amounts required are not large, certain grades of steel cannot be made without them, and dependence on foreign countries is likely to be embarrassing in event of a national crisis, as was shown by the experience of the last war. Domestic unmined reserves of gold and precious stones also are inadequate, although their scarcity raises problems that are largely other than industrial in character.

Public encouragement is warranted for exploration in search of additional supplies of deficient minerals, for investigation of the possibilities of developing the use of substitutes, and for technological research that may make available low-grade and marginal supplies that cannot now be extracted profitably. Within the narrow limits of available funds, Federal and State agencies concerned with geology and mining have performed a valuable service in carrying on investigations of problems relating to these minerals. Expenditures for carrying forward this work on a more extensive scale are advisable. While in the past some of the efforts of Federal and State agencies have been devoted to expanding production of minerals already in surplus, now energy should be directed mainly to questions of increasing reserves of deficient minerals.

To encourage development of certain minerals in which we are deficient, such as manganese, mercury, and tungsten, tariffs have been imposed. It has usually been argued on behalf of tariffs—often without careful scrutiny of the reserve situation—that they would make possible the development of new supplies. In practice, however, the encouragement of tariffs has not greatly aided exploration, discovery, and research; on the contrary, the stimulus of a protected market of uncertain duration has merely accelerated the depletion of the few high-grade deposits we have at a time when consideration for national defense requires that such limited supplies be conserved for emergency use. The wisdom, moreover, of tariff protection for minerals of which the small (actual or potential) domestic production meets only a minor portion of consumption requirements is open to further questions with which the committee is not primarily concerned.

As tariffs have generally failed in their objective to materially improve either the short-time or long-time outlook of deficient minerals, a more effective procedure would be the increase of direct appropriations to continue surveys, exploration, and technological experiments. The latter particularly have already proved their worth. A few years ago the United States was almost totally dependent upon European sources for potash; Federal Government-sponsored drilling in New Mexico, Utah, and Texas, inaugurated in 1927 after extensive geological reconnaissance, has now definitely assured adequate supplies of domestic potash. Similarly, Government-supported technologic studies on the recovery of helium gas have assured supplies adequate to meet all present domestic needs and have provided a reserve against future demands; in 1917 this gas was available in small quantities at a price of $2,500 per cubic foot, but by 1933 the recovery processes developed by Government scientists provided helium at about half a cent a cubic foot. Private research has also made noteworthy contributions, such as the successful extraction of the interesting and useful magnesium metal from brines.

The methods that have made available supplies of potash, helium, and magnesium metal promise further results when applied to some of the other deficient minerals. For example there are large reserves of low-grade manganese-bearing material already known in the United States. Experimental work on the recovery of manganese or manganese-bearing products from these sources and their use has come near enough to success to justify public expenditure for further experimental work. While such work as has been done has been indirectly encouraged by the tariff, it has resulted mainly from private, State, and Federal research activities that have not been greatly influenced by tariff considerations. Further surveys are needed to indicate those minerals which seem to merit special exploration and research efforts. If and when it can be shown that adequate supplies of the minerals which are now deficient can be found and made available by new processes at costs somewhat above world prices, then careful consideration should be given to the advisability of tariff protection.

SECTION II

V. MINERALS AND THE PROBLEM OF MONOPOLY

The restricted occurrence of many minerals invites concentration of ownership. Nature in some cases creates conditions that make monopoly almost inevitable as man creates similar conditions for limited periods by patent laws. Ninety percent of the radium produced in recent years has come from one deposit. Until 1924, about 60 percent of the world's vanadium came from one mine, and another mine now produces 75 percent of the total production of molybdenum. There is only one deposit of natural cryolite of commercial size known in the world.

Some other minerals are widely distributed but a few deposits are so rich or so readily amenable to recovery that they create a similar situation. Eighty percent of the world's output of so common a mineral as native sulphur is taken from five deposits controlled by two companies. This particular type of deposit lends itself so well to an ingenious, specially adapted, low cost method of recovery that the production dominates the world's markets.

Concentrated ownership in other cases may arise partly out of limited distribution of resources and partly out of control of patents, reduction plants, fabricating capacity, marketing facilities, or exceptional technical and managerial ability. One company controls the greater part of the known reserves of bauxite (the ore of aluminum) of present commercial grade in the United States and 100 percent of the reduction capacity for the making of virgin aluminum.[1] From such unitary control, the problem of concentrated ownership grades off into the condition illustrated by the California borax deposits; or by the high-grade ores of Lake Superior, where the bulk of the better reserves are in a few hands, although the Supreme Court in the steel case found no violation of the antitrust laws. The minerals involved in situations of this type range from those affecting only minor industries, relatively unimportant in the total volume of industrial production, to some of the world's major enterprises.

American law and tradition are opposed to unregulated monopoly. It is notable that some of the leading cases brought under the antitrust laws have been directed at alleged combinations involving control of mineral raw materials. The issues have been brought not by consumers only on the basis of excessive prices, but also by smaller producers who have felt themselves deprived of a fair market, or from independent refiners.

In this connection the committee calls attention to economic forces tending to protect the consumer of mineral products even where concentrated ownership prevails. All metals are subject to the competition of substitutes and the competition becomes more fluid with the advance of modern metallurgy and the chemistry of alloys. High prices stimulate the return of consumers' scrap. New deposits may be discovered at any time. Thus the dominant position in the vanadium market held for 15 years by a single mine in South America has been challenged by active competition from Africa. The virtual monopoly of radium enjoyed for 10 years by a mine in the Belgian Congo is now threatened by the discovery of new deposits in northern Canada. Synthesis of minerals through chemical advances may supply competitors of the natural product, as illustrated by the development of synthetic cryolite. The importance of such extra-legal forces in protecting the consumer is well shown by the anthracite industry of Pennsylvania. The final court decree directing the anthracite railroads to dispose of their coal mines was entered years ago, yet it is now clear that the legal processes of dissolution had less effect upon prices than the economic forces of competition from substitutes.

Although the committee believes that competition is the most effective general regulator of price and the one that best accords with American practice and the American genius, it recognizes that natural conditions preclude its effective operation in some parts of the field of the mineral industries.

The issue raised by concentrated ownership of minerals is, of course, only a part of a much larger question affecting all branches of industry and trade, yet it has certain special features. Thus the committee is aware of certain advantages of centralized ownership in the mineral industries. Where such ownership exists, it has some times avoided much of the resource waste associated with destructive competition among great numbers of producing units as well as the poor housing conditions so often associated with mining camps in the highly competitive industries. Concentrated ownership also has made great contributions in carrying new industries through the pioneer stage, in advancing mineral technology, and in developing new uses and new markets. On the other hand, there is always the possibility that monopoly control may

[1] From testimony by officers of the company given on pp. 20 and 124 of the transcript of the public hearing on the Code of Fair Competition for the Aluminum Industry, National Recovery Administration, 1933.

strangle legitimate competitors and exact unreasonable prices. Unless an industry is operating under public regulation, the consumer is right in feeling that competition is necessary to assure a fair price.

In those industries burdened with a surplus of capacity such as coal and oil, for which we have recommended the encouragement of collective action among producers to control production, we have also recommended adequate public supervision. The suggested arrangement aims not to suppress competition but to confine it within orderly bounds. A measure of competition to stimulate efficiency and the progress of the arts is healthy and necessary. The objectives of production control should be rather to attain economic stability and to prevent serious waste of resources. For these purposes, as already indicated, we believe that collective action by an industry to control output, capacity, and even in some cases, prices, may be in the public interest. Such collective action may appear to be in conflict with the traditional interpretation of the antitrust laws. If necessary we think the laws should be amended to permit collective action, but always under public supervision. The degree of supervision necessary in a given case obviously depends upon the extent to which free competition is to be modified, but in all cases should be ample to protect the rights of labor and the consumer.

Where there is no adequate supervision of price or production by public authority, the committee thinks it clear that the antitrust laws should be retained in full and vigorously enforced, whether the industry involved is one of many units or of few. This is the more appropriate because of the facilities for collective action under public supervision, made available by the Recovery Act or by the permanent provisions which we have suggested. Practices in control of competition that can be shown to be in the general interest are thereby made possible under public supervision. If there should be practices in control of competition that any business group is not willing to conduct under public supervision, these practices would be open to the suspicion that they constitute an unreasonable restraint of trade.

In discussing this subject, the committee bears in mind that the question of enforcement of the antitrust laws extends far beyond the field of mining. Even where mineral raw materials are involved, practices complained of as in restraint of trade may center around the fabrication of the finished product for sale to the ultimate consumer and therefore may involve manufacturing and distribution rather than mining. The committee has made no study of these practices. They raise legal questions outside its competence and its terms of reference, which are the responsibility of the agencies of the Federal Government charged with enforcement of the antitrust laws. The committee assumes that these agencies will be vigilant in prosecution of violations.

Where there is only one deposit of a mineral and that too small to permit economical development of more than one mine, the public interest is doubtless best served by unitary operation. But where deposits are sufficiently large or scattered to permit several enterprises of a size great enough to achieve the economies of large-scale operation, the committee believes that competition between several producers is healthier than monopoly. The provisions for collective action under public supervision which have been sketched offer a means of keeping competition within reasonable limits and insuring orderly conservation of the resources.

SECTION II
VI. MINERALS ON PUBLIC LANDS

Factual Review

There are about 1,903,000,000 acres of land within the United States proper. Of this total about 1,442,000,000 acres constitute the so-called "public domain", that is, the area that was once public land and under the direct control of the Federal Government. More than 1,000,000,000 acres of this total have been disposed of leaving about 426,000,000 acres directly or indirectly in Federal control. The Commissioner of the General Land Office in his annual report for 1933 classifies this remainder as follows:

	Acres
Pending and unperfected public-land entries	23, 208, 704
Title remaining in the United States:	
Unappropriated and unreserved public land	172, 084, 580
National forests	137, 576, 500
National parks and monuments	8, 370, 989
Indian reservations (estimated net)	56, 676, 535
Military, naval, experimental reservations, etc. (approximate)	1, 000, 000
Withdrawals (estimates net)	27, 068, 532

Such part of the original mineral resources of the Nation as is still under Federal control is in this remaining fraction of the public domain and in about 35,000,000 acres of lands that have been disposed of with a reservation of some or all of the contained minerals by the United States.

The retention of these resources in public ownership, and the evolution of the leasing system under which they are now yielding a substantial revenue to both the Nation and the interested States, are an outgrowth of the original conservation movement launched by President Theodore Roosevelt early in the century. The coal and oil land classifications and withdrawals of 1906 and since, and the Mineral Leasing Acts, the most important of which is that of 1920, constitute changes in administrative practice and in law brought about by the conservation movement. There remains the continuing task of vigilant administration of the statutes enacted, and of securing such modifications of them as will assure the realization of the conservation objectives.

Methods of Disposition of Minerals

There is a complex body of Federal law under which publicly owned mineral deposits may be acquired and developed. In a broad sense, the Federal laws for the disposal of these resources recognize two categories of mineral deposits—the metalliferous and the nonmetalliferous. Again speaking broadly, the metalliferous mineral deposits may be acquired in fee under the lode or placer acts and the nonmetalliferous deposits may be developed under a group of leasing laws. Location of a mining claim, followed by certain simple legal procedure, including the recording of notice of location in the appropriate county office and proof of annual assessment work, gives the locator a property right recognized by the courts. The locator may obtain a patent on discovery, an expenditure of not less than $500 on the claim, and payment of the purchase price, $5 per acre for lodes and $2.50 per acre for placers, but a patent is not necessary in order that definite property rights may be acquired, so long as the provisions of the mining laws are complied with. Indeed, mineral patents are often deliberately avoided by claim owners to escape taxation or for other reasons and important mines in the United States have been developed on claims that have never been patented.

Metalliferous mining claims may be filed upon any part of the 172,000,000 acres of unappropriated and unreserved public lands, upon the 138,000,000 acres of national forests, and upon some part of the 35,000,000 acres disposed of with a reservation of mineral rights by the United States. It is unlikely that there remain any important known deposits in these areas that are not included in mining claims. The Federal Government has no record of these claims unless title is sought or contests are brought.

Generally speaking, the mining laws are not applicable to lands withdrawn and reserved for national parks and national monuments, although claims established prior to the creation of these reserves and maintained in compliance with law remain valid.

The lode and placer mining laws are not applicable generally to lands within Indian reservations. However, various special acts have been passed from time to time providing for the development of metalliferous minerals within Indian reservations by lease. Perhaps the most important of these acts was that of June 30, 1919, which, as amended on December 16, 1926, authorizes the Secretary of the Interior to lease any part of the unallotted lands within any Indian reservations in the States of Arizona, California, Idaho, Montana, Nevada, New Mexico, Oregon, Washington, or Wyoming for the purpose of mining deposits of metalliferous and nonmetalliferous minerals except oil and gas. This act

provides for the collection of 5 percent of the net value of the output of the minerals as royalty.

Lands withdrawn under the terms of the Withdrawal Act of 1910 in general are open to acquisition under the mining laws applying to metalliferous minerals. The Water Power Act of 1920 reserves lands, covered by an application filed under that act, and lands withdrawn or classified as valuable for power purposes from any type of subsequent mineral location or entry.

Coal, oil and gas, phosphate, potash, sodium, sulphur (in Louisiana and New Mexico), and oil shale on Government lands are now acquired not by purchase but by lease. Laws for the development and production of these substances provide for the issuance of prospecting permits for all except phosphate and oil shale. After discovery leases may be issued for lands included in these permits at royalty rates whose minima are usually fixed in the law. Leases may also issue, in general, to the bidder of highest bonus, for known deposits for which prospecting is unnecessary. These minimum royalties are for coal, 5 cents per ton; for oil and gas, 5 percent of the gross value of the crude production from a quarter of the area included in the prospecting permit and not less than 12½ percent for the remainder; for potash, not less than 2 percent of the quantity or gross value of the output at the point of shipment to market, etc. Common royalty rates for coal are 10 and 15 cents per ton and various rates above the minimum, including sliding scale rates up to 33⅓ percent, are applied to oil.

The maximum acreage that may be included in single permits or leases under this group of acts is usually 2,560. No persons, association, or corporation may hold coal, phosphate, or sodium leases or permits aggregating more than 2,560 acres in any one State, nor more than 7,680 acres in any one State under oil and gas lease or permit. The original lease term is usually 20 years, with provision for renewal by successive 10-year periods. An acreage rental is provided for, to be credited against royalties when minerals are produced.

These leasing laws apply to the unreserved public domain and to the national forests (except those reserved under the Appalachian Forest Act, which may be leased under a special act), but not to the parks and monuments. Oil and gas deposits in lands included within naval petroleum reserves are developed and produced either under the general leasing act or under a special act applying to these reserves. A group of special statutes provide for the development of oil and gas, lead and zinc, and coal on Indian reservations, generally by lease and under conditions comparable with but not identical with those applying to the public domain.

Operations on the public lands under the leasing acts are indicated in the following summary:

Minerals	Number of leases outstanding on June 30, 1934	Total acreage under lease	Total revenues accrued to June 30, 1934
Public lands:			
Oil, gas, and gasoline	848	294,720	$76,248,922.70
Coal	350	69,332	3,917,969.41
Phosphate	8	4,233	31,261.25
Potash	12	29,465	216,985.75
Sodium	1	640	10,571.88
Oil shale	1	2,680	6,700.00
Naval petroleum reserves: Oil, gas, and gasoline	24	9,948	27,245,625.03

The total income that has been derived by the Indians from the development of minerals on the reservations is about $345,000,000 for oil and gas and would aggregate about $400,000,000 for all minerals. The diversity of this activity and the number of leases and the acreage involved are indicated in the table below:

Minerals	Number leases outstanding on June 30, 1933	Total acreage under lease
Indian lands:		
Oil, gas, and gasoline (June 30, 1934)	6,534	711,843
Lead and zinc	41	5,924
Asbestos	15	1,474
Marl	9	548
Gold	13	1,030
Gypsum	1	219
Gold, silver, copper, etc	11	501
Limestone	2	280
Copper, lead, and zinc	1	50
Copper	3	200
Asphalt	1	80
Coal	37	15,576

Production from Public Lands

Mineral production from public lands is in general but a minor proportion of the total United States production. Potash is an exception because of the late discovery of bedded potash salts in southeastern New Mexico in deposits owned by the United States.

An idea of the relation between public-lands production and total production is given in the following table for the year 1933.

Mineral production in United States

	Total, United States, calendar year 1933	From public lands and reserves, fiscal year 1934	Percentage public lands of total United States production
Petroleum ..... barrels	905,656,000	[1] 28,775,910	3.1
Natural gas ..... M cubic feet	1,480,000,000	62,194,904	4.3
Bituminous coal ..... tons	327,940,000	2,688,687	.8
Phosphate rock [2] ..... do	2,688,000	43,067	1.6
Potash salts ..... do	333,110	294,156	88.3
Sodium salts ..... do	305,047	46,047	15.1

[1] In addition 23,822,148 barrels of petroleum were produced from Indian lands.
[2] Estimated.

The revenues derived from public lands as a result of the operations of the leasing acts are distributed as follows:

	Percent
United States Government	10
States	37½
Reclamation fund	52½

Royalties received from oil and gas leases on the naval petroleum reserves are deposited in the United States Treasury as miscellaneous receipts, and royalties from Indian lands are credited to the tribe or allottee entitled thereto.

Federal Policies for Minerals on the Public Domain

From 1785 to 1846 the policy of the United States as to minerals on the public lands was one of reservation and lease—an exception being the opening to sale of lead mines and lands in Missouri in 1829. Knowledge of mineral deposits and use of minerals was meager a century and more ago, and these early laws were applicable chiefly to lead, though reservation of gold, silver, copper, and salines was provided. In 1846, following a report by the President in 1845 that the reservation of a million acres of land supposed to contain lead and other minerals and the leasing of such reserved lands was unprofitable to the Government and unsatisfactory to lessees, Congress authorized the sale of reserved lead mines and lands in Arkansas, Illinois, Iowa, and Wisconsin. Thus was inaugurated a policy of sale which was extended to other areas soon thereafter and to coal in 1864.

Among the reasons given for the abandonment of this early leasing experiment was the cost of its administration, reported as more than four times the revenue—in marked contrast to a revenue many times the cost under the conditions of 1934 and because of destruction of timber and the careless and wasteful manner of working the mines—again in marked contrast to the conservation of life, health, and resources accomplished through supervision of present-day mineral-lease operations.

Discovery of gold in California in 1848 led to a change in policy and law. In the absence of any governmental organization, either congressional or territorial, and in the absence of specific Federal law other than that reserving mineral lands from preemption, local customs, varying with different localities, grew up by common consent of miners and governed the location, size, and possession of mining claims and appurtenant water rights. By 1866 nearly a billion dollars in gold and silver had been produced from public lands of the West under these customs which came to be recognized by the courts and legislatures. Finally, in 1866, Congress recognized and validated equitable rights acquired in accordance with such local customs and provided that mineral lands of the public domain should be free and open to exploration and occupation and to acquisition by conforming, in general, to established local customs. Thus, except for coal, which remained under a policy of sale and purchase established in 1864, the general mining law of the United States became one of possessory occupation. The principle of sale and purchase was extended in 1870 and 1872 to mineral lands generally at the nominal price of $2.50 an acre for placer claims and $5 for lode claims, conformity with established rules and customs of local mining districts still being a general requirement.

In 1914 Congress revived the leasing system by enacting a coal-leasing law for Alaska and in 1917 extended the policy to potash on all public lands of the United States. In 1920 a general leasing law for coal, oil and gas, phosphate, oil shale, and sodium was passed. In 1927 this was extended to cover sulphur, and in the same year the principle of leasing was applied to gold, silver, and mercury reserved to the sovereign in certain existing land grants.

These relatively new leasing laws have proven advantageous both to Government and industry. There is, however, a strong body of opinion that under them speculation in mineral rights has been excessive and that provisions intended to encourage discovery of new sources of supply have permitted unwise promotions with resultant loss to the general public and to diversion of the landowners' equity to middlemen who do little or nothing for the benefit of either Government or industry. Amendatory legislation and improved administration to correct such abuses are suggested. But the general workability of the leasing laws and the advantages in conservation of life, health, and resources obtained through their operation have been amply demonstrated through a period of years. One has but to consider the course of development in two major oil fields during a time of general overproduction—Kettleman Hills, California, a public-land area, in which production has been held back, and east Texas, a non-public-land area, in which it proceeded apace with resultant disorganization of markets—to be convinced that control exercised under Government ownership has been beneficial to the industry and to the Nation.

But other Government-owned mineral products, except the designated few, remain subject to the general mining laws under a highly decentralized, independent, individualistic system. Under it Government has no cognizance of rights established to public resources. So far as any requirements of the system are concerned the Federal Government does not know what mineral resources in the public domain are still public property and what are covered by valid claims which any court must recognize. Such a situation under modern con-

ditions in a well-developed region is an anachronism. Under it Government cannot function effectively as a trustee of the national resources. Administration is baffled. It may determine that the highest value of a tract of land is for park purposes or for power or irrigation development or for forests or for playgrounds, only to discover that a valid mining claim on which "discovery" has been made and annual assessment work is done, exists at the critical point. The period when laws of this character were needed to make possible prompt and successful development of deposits of metalliferous minerals in mainland United States is past.

It is probable indeed that few known deposits of metals or their ores that are not covered by a mining claim exist in the 400,000,000 acres of public land remaining. Some new discoveries, however, will doubtless be made.

Future mining development should be provided for by an extension of the leasing principle, though probably in much simplified form, to all publicly owned mineral deposits in the United States proper. Moreover, if legally practicable any new enactment should provide that within a reasonable period all holders of claims then extant should be required either to apply for patent under the old law or for a lease under the new law. By this process existing rights will become a matter of Government record. Thus the present chaotic condition will gradually be cleared up and the Government will be in a position to function effectively as the administrator of all the public mineral resources.

Both the States and the Federal Government are at present expanding their holdings of land and the resources that they contain. Lands thus acquired by the United States will become in some sense public lands and their contained minerals should be brought into the general leasing system and administered as are those of the residual public domain.

Federal influence with States should be directed toward encouraging a form of State management that will harmonize with Federal policies. Abundant examples now exist of the disadvantages and confusion that arise from differing State and Federal policies on adjacent lands.

The possible advantages of Government control and management may be thus summarized:

(1) Substantial revenues are collected of which the States receive a large share.

(2) Conservation is fostered through reduction of waste and encouragement of greater ultimate recovery.

(3) Adjustment of rate of production to market needs is aided.

(4) Control of monopoly and of harmful price fluctuations is fostered.

(5) Care in operation and safety and welfare of workmen can be imposed.

(6) Maintenance of reserves of essential minerals can be assured.

Possible disadvantages may be similarly summarized:

(1) Increase of Government staffs and costs (bureaucracy).

(2) Interference with freedom of action of citizens.

(3) Danger that Government efficiency may be destroyed at any time by the withholding of appropriations necessary to administration.

(4) Instability of policies under changing administrations.

(5) Possibility of political favoritism in administration.

Alaska

Alaska is still a frontier. It is still largely unsurveyed public land. It is not an agricultural nor an industrial region in the mainland sense. Its valuable timber is limited essentially to the southeastern coasts. It is and is likely long to remain chiefly a mining region. In any of its lands outside of national forests that contain commercial mineral deposits, those deposits quite certainly constitute the chief value of the land. There is, therefore, little or no conflict of values. Its resources of fuel minerals and fertilizer minerals are now subject to exploitation only under Federal lease. The old mining law in its application to the metals is simple of operation and effective in frontier regions. It requires the minimum of administration. Indeed, it is in effect self-administering, whereas leasing laws require adequate administrative staffs. This is proper, indeed almost essential in remote regions, with short working seasons and inadequate transportation, if mining is not to be hampered. An elaborate procedure, requiring official action at Juneau or Washington before the right to take placer gold from a creek near the Arctic Circle can be acquired, is impracticable. The Government may well forego such royalties as it might receive under a leasing system in such circumstances.

It is therefore not recommended that the lode and placer acts be repealed in their application to Alaska except in the National Forests to which the leasing principles should be applied. However, a simple requirement is not unreasonable that a duplicate of the filings made at the local district office be forwarded to the nearest land office for record. Such a procedure would give the Government cognizance of claims existing on the public lands of the Territory. It has no such record at present.

SECTION II

VII. EXTENSION OF GOVERNMENT OWNERSHIP

As a phase of the growing tendency in all parts of the world to extend public control over natural resources, increasing interest is manifest in the possibilities of Federal or State acquisition and administration of mineral resources now in private ownership. Few political platforms in recent years, either National or State, have failed to include a plank on natural resources or to advocate measures designed to effect the greater conservation and more definite control of such resources for the benefit of the public as a whole. There is unquestionably a growing feeling that the minerals are a common heritage, that their exploitation should, therefore, be for the benefit of all rather than of the few, and that the wasteful practices of unregulated private exploitation can be eliminated only by a greater degree of Federal or State control than is now exercised.

While approving the policy of retaining ownership of mineral deposits on the public domain within the United States proper, to be administered under a leasing system, your committee does not recommend general extension of public ownership at the present time to the deposits of coal, oil, gas, iron, copper, lead, zinc, gold, silver, and a score of lesser minerals that have already passed into private hands. Whatever the abstract merits of public ownership may be, private ownership is so inherently a part of the American genius and tradition, and is so firmly entrenched, by law and custom, as a national policy, that the practical difficulties alone of any general reversal of the status quo at this late date appear insuperable. However, future conditions cannot be forseen and the committee recognizes the possibility that restoration to public ownership of minerals now privately owned may sometime become a desirable feature of national policy.

Many of the recognized ills of the domestic mineral industries—excess capital investments, variable and uncertain market demands, and irregular tenure of labor—are such as inhere in an industrial civilization founded on the generosity of nature and governed by the laws of supply and demand and the survival of the fittest. These and the problems peculiar to mining, which center around the fact of exhaustibility, can best be dealt with by private operation under public supervision along the lines recommended in our discussion of production control (sec. II, I). The consensus of this committee is that under present conditions the feasible limits of public control are encompassed by the principles of the producing and marketing cartel, or code, duly modified to protect the rights of the producer, large or small, and of labor and the consumer, and strictly and impartially administered in the public interest by the Federal Government, supplemented where needed by use of the police powers of the States to prevent waste in mining.

In this policy of attempting no general extension of public ownership, two minor modifications should be considered. The first relates to the proposal to purchase and retire some of the marginal coal mines and a portion of the coal reserves now in private hands, to which reference has already been made. In this case the proposal for public acquisition is supported by industry. It involves no attempt at Government *operation* of mines, but merely the creation of an eastern coal reserve (consisting of selected blocks of acreage) to be administered in much the same way as coal reserves on the western public lands. If this proposal is found to be the best way of meeting the problems of surplus capacity and stranded mine workers in the bituminous coal fields, as we think it possibly may, the favorable results obtained under the Mineral Leasing Act seem to indicate its feasibility from the viewpoint of public land administration.

The second modification relates to mineral deposits reverting to public ownership by the process of tax delinquency. Where tax-delinquent minerals are unredeemed, there is clear proof that existing reserves in private hands are more than sufficient for the needs of the local industry. To suppose that forced sale of such deposits will increase the State's revenue is often an illusion. Its effect is rather to depress the taxpaying ability of other mineral owners. Forcing such lands back into private ownership stimulates the vicious cycle of overexpansion of mine capacity in order to meet carrying charges on reserve holdings, with its train of capital loss, intermittent employment, and resource waste. A seemingly wiser course would be for the States to hold tax-delinquent mineral deposits in reserve until such time as they are actually needed, and then to lease them with payment of suitable royalty to the State, after the manner of the Mineral Leasing Act on the Federal domain. This point involves the need of change in present methods of mine taxation, which is discussed in Section III–X.

SECTION II

VIII. SUBMARGINAL MINERALS AND MINERAL LANDS

Mineral deposits may be marginal or submarginal producers because of varied circumstances. They may be too small to warrant investment in a plant sufficiently large to form an economic unit, or too low in grade to permit economic operation under existing conditions or in the near future; also, they may be too far from market. Furthermore, so much of a given mineral may be easily available that the market cannot absorb it all over a term of years at prices that will meet the expense of taxes and the cost of holding the investment. Mineral lands in the latter category have no real present value as mineral lands and the attempt to set them earning their board and keep merely disorganizes the industry. In addition, some deposits are in an anomalous position as they may be submarginal in times of depression although commercially productive in periods of great demand or high prices. The problems of mineral reserves of this type have been discussed in part in the section on conservation issues arising from surplus production or surplus plant capacity. Here we refer particularly to mineral deposits which, because of low grade, small size, high cost, unfavorable location, or advanced depletion are likely to remain submarginal for the immediate future, say for the next 10 years. All reserves of this character will doubtless be needed some decades hence as the richer deposits are exhausted, but meantime where prematurely opened they have left the communities dependent on them derelict and stranded.

The acute situation that exists in marginal agricultural areas has been forced upon the attention of the public by the present business depression. It is not so generally recognized that a parallel situation exists in mineral lands, due to much the same kinds of causes. The influences which led to breaking up and putting into wheat cultivation what now proves to have been too large an acreage for our present and probable future requirements were not fundamentally different from those which led to opening too many coal mines. Both cases raise a problem in resource conservation, and each contributes to the waste involved in excessive competition, failure, and abandonment. In both cases society is concerned in checking present waste and in preventing its repetition.

But equally urgent is the human problem, and here the miner suffers perhaps even more than the agricultural worker. Wheat land can be turned to other uses but a coal mine can yield nothing but coal. The cotton farmer is in an area where the possibility of other industries exists; too often the copper miner is in an inhospitable region where even his water supply fails when the mines shut down. Mines are necessarily where the mineral occurs, and it is an exception when other than subsidiary industries can be sustained in a mining town. When the mines close down the community dies; the towns, the railroads, and even the farmers in the vicinity find their market gone, as is true today, for example, in parts of Utah and other Western States.

One of the obvious lessons of this experience is the need not merely to alleviate the present hardship by such means as can best be applied in each case, but also to set up agencies that may serve as observation posts from which may be signaled warnings to industry so that similar acute situations may in the future be anticipated and avoided.

There is danger that in the haste to put more men to work they be merely set at reopening or enlarging marginal mines that will inevitably be high-cost producers, whose output, so far as it can be sold at all, will merely displace the product of low-cost mines already in operation and already employing labor. Just such projects for the opening of doubtful mineral deposits have been urged by various planning boards and committees and requests have been made for public funds with which to carry them out. Obviously, in cases where an actual surplus or a surplus capacity to produce already exists, further opening of marginal properties would be shortsighted.

In search, also, for uses of power to be generated by the great hydroelectric projects now being built as public works, care must be taken to avoid merely increasing present troubles of the mineral industries by encouraging unneeded production from marginal or submarginal deposits as an outlet for surplus power. Such operations can only survive by reason of a direct or disguised subsidy. In this connection the fundamental relationship among the three great sources of power—coal, oil, and hydro plants—should be understood and articulated in any broad power program, and the protests of the coal producers and mine workers against alleged too rapid development of hydroelectric projects at public expense warrants careful study to determine their merit.

For minerals already developed to surplus capacity, it is obvious that development of further submarginal supplies should be discouraged. Our recommendations for production control for some of these minerals in Sec. II, III include discouragement of new development. With the limits of demand more generally recognized through the issuance of consumption forecasts, recommended in Sec. II, III of this report, and with the knowledge that production must be kept within certain bounds, the explorer is likely to show more caution and will find it more difficult to secure backing for new enterprises than when the market was so wide and expanding that the question of ability to sell the product was a secondary consideration. If the Securities Commission should require a full statement of demand and market limitations in connection with the sale of stock issues, it might do much to discourage unwise development.

It is recognized, of course, that such a program may have to be compromised temporarily with the local necessities of employment.

For minerals of which the supply is known to be inadequate for the needs of this country, other measures should be taken. Whether it be to meet needs of national defense or to furnish raw materials for domestic industry, every reasonable encouragement should be given to those willing to venture their capital in development.

An exception to this general thesis may well be expressed in that the development and use in peace time of limited domestic deposits of critical war minerals should not be encouraged.

Topographic and geologic surveys have long been recognized as essential prerequisites to intelligent development and should be vigorously supported from public funds. In particular instances, special studies in the technology of production and recovery require reasonable expenditure of public money that is clearly justified. In the readjustment of public and private ownership in lands, whether by extension of the national forests and the national parks, the purchase of marginal agricultural lands, the forfeiture for taxes, or by other means, careful studies should be made to determine the mineral value of such lands and to classify them as to future usefulness. In instances where it is feasible to do so, it may prove to be sound public policy to take certain marginal mineral lands into the public domain. The cost of carrying them until they are needed will thus be minimized, and when that time comes the conditions of development can be set without prejudice to vested rights.

A more general understanding of national needs on the part of both Federal and State Governments and on the part of both permanent and emergency agencies of government should make it possible to support more adequately investigation of the problems of supplying our national deficiencies. The National Resources Board, through its contacts with State planning boards, could perform a very useful service in indicating just what minerals should be and should not be developed. Federal and State relief agencies should in all cases withhold support from new mineral developments except where it can be shown that supplies in the United States are really deficient at a reasonable price and that new production will not displace production elsewhere that has a better right to maintenance nor tend to exhaust limited supplies of minerals essential to national defense.

There remains the question of what to do with the stranded population of many mining districts, some of them large and well known, which are either so far exhausted or inherently so close to the margin that they cannot hope to compete successfully during the next decade. Much attention is being paid both by the Federal and State Governments to proposals for vacating marginal agricultural lands and moving the population to more productive areas. Zoning is already under way and there are suggestions for its wide extension. Minerals have been considered only incidentally in these moves, and no provision has yet been made for the derelict mining camps or their inhabitants.

Your committee has not had the time to make the studies necessary, but feels sure that the problem of what to do with submarginal lands involves consideration of the resources existing below the soil as well as those in and above it. Lands should not be vacated or put in the public domain or in forest and game preserves without ascertaining first whether any needed mineral supply is being taken out of the field of possible development. Steps should be taken to rehabilitate the thousands of metal miners and scores of thousands of coal miners who cannot hope to make a living in their present surroundings. The condition of these men and their families is perhaps the most tragic of any group of American workers. Openings must be found for them in other industries, local if possible, and, if not, in other regions. This is now recognized to be a social responsibility and, where necessary, a Government responsibility. In this connection serious consideration should be given to the suggestion (already referred to) of financing the retirement of marginal coal mines and the rehabilitation of displaced miners by means of a small tax on the tonnage of the more successful mines remaining in operation. Your committee recommends that an investigation of this entire problem be made a continuing activity of the National Resources Board.

SECTION II
IX. TAXATION

Federal Taxation

The Federal Government taxes domestically produced minerals through the income tax. The income tax involves questions of conservation through provisions which make capital allowances for discovery, thereby reducing the tax and encouraging exploration and development. The discovery clause in the income-tax law was introduced during the war, the justification given at the time being primarily the purpose of speeding up oil development. While it applied to all minerals, regulations of the Treasury Department restricted discovery exemptions in the metallic minerals to a far greater extent than in oil. In 1921 the discovery clause was supplemented for oil and gas by a percentage depletion clause, liberalizing the depletion exemption of these commodities. The exemption on oil has amounted to about half of the net income. In 1932 the discovery clause, as it applied to coal, sulphur, and metals, was replaced by the percentage depletion provision.

The reason originally assigned for the allowance of deductions based on discovery value or percentage depletion—encouragement of exploration and development of oil—becomes nonexistent in mineral industries suffering from surplus problems. Whether or not the income deductions permitted to mineral producers have actually expanded development is not clear, though in any case their effect has probably been small. In 1934 the Secretary of the Treasury recommended to Congress the repeal of the discovery and percentage depletion provisions on the ground that in effect they were subsidies to a special class of taxpayer.

Your committee makes no recommendation on this subject but suggests there should be a study of the possible contradictory effect of the discovery and percentage depletion provisions in the income-tax law in promoting further development for the few minerals for which present overdevelopment and waste are so excessive that production control appears to be necessary. Also, the possibility of confining the special mineral depletion allowances to minerals for which production control is not necessary should be examined, particularly with reference to minerals of which the United States' supplies are deficient.

Within the last year the Federal Government has imposed a tax of one-tenth of a cent per barrel on petroleum to be paid by the producer at the point of production, one-tenth of a cent per barrel to be paid by the refiner at the refinery, and one-tenth of a cent per barrel on gasoline produced from natural gas. The purpose of these taxes is to defray the cost of administering the petroleum code. In addition to its value as a revenue-producing measure it has been of considerable assistance in disclosing the illegal production of oil.

Excise taxes, which are in effect import tariffs, have been imposed on coal and oil when imported into this country, consequently they will be treated elsewhere.

Federal, as well as State and local, taxes are imposed on the retail sale of gasoline but, as these are in the nature of sales or consumption taxes levied primarily for highway construction, they should be considered by other agencies than this committee.

State Taxation

The heaviest burden of taxation on mineral industries is imposed by the States, counties, and townships. Inadequacy of assembled data prevents discussion of this complex field in detail, but we wish to call attention to certain general trends as they affect the problems of conservation.

Most of the States have ad valorem taxes, both on active mineral properties and on mineral reserves. The reserves are taxed annually for indefinitely long periods before coming into production. In some States the ad valorem tax is based on a larger proportion of true value than for other classes of property. In addition there is, in some jurisdictions, a multiplying group of special taxes on minerals, called "tonnage taxes", "severance taxes", "occupation taxes", and "royalty taxes." There are other special taxes on smelting, refining, and distribution. Some of the States have corporate income taxes. It is claimed by some mining companies that the cumulative effect of these measures is to burden minerals with a load of taxation heavier than other classes of property, in certain cases so heavy that it is said to approach confiscation.

The reason for this heavy burden, where it exists, lies partly in the growing feeling that natural resources are a heritage of the people and that the public has certain special rights in them, regardless of their private ownership. This feeling is often expressed in legislative discussions of tax measures, in reports of tax commissions, and in political platforms. Another reason is that so many of the large mineral properties are in absentee ownership. The taxation trend reflects in

some cases an indirect effort to reacquire natural wealth which has passed into private ownership. Reinforcing these philosophical considerations is the very practical point that mines and minerals cannot escape heavy taxation by moving away, and that their value often bulks large in relation to other local property. Under these conditions, local taxing bodies, in need of more revenue, find it difficult to exercise restraint.

All industries, however, share in the problem of heavy taxation, and in this report we are interested primarily in the question as it affects the conservation of exhaustible resources. Of all taxes on minerals, the one which is most likely to be anticonservational is the ad valorem tax collected annually by the States on all minerals whether in production or in reserve. The effects of this tax are cumulative and some of them are only beginning to be recognized. Owners of mineral reserves are driven to open mines in order to provide income enough to meet their taxes, and the ad valorem tax has been one of the causes of overdevelopment of mine capacity, especially of the coal mines. It has a tendency to force selective mining with attendant loss of low-grade material. It handicaps the orderly development and extraction of the miscellaneous grades to be found in most mineral districts. It puts a premium on the use of methods of extraction which cost the least, regardless of the fact that these methods often involve the permanent destruction or locking up of important reserves costing more to extract. In all these undesirable results the ad valorem tax is only one of many factors, but that it is an important factor there can be no reasonable doubt. Moreover the valuations on which ad valorem taxes are based are largely matters of personal judgment requiring highly experienced appraisers, and it is not surprising that there should be enormous disparities of tax between individual properties and between taxing divisions and between States.

Another major result is just now looming up. It is becoming apparent that by the time many of our great mineral reserves reach the stage of production they will have accumulated a charge of original cost, taxes, and compound interest far beyond any possible return from operation. This is particularly true of the coal, iron, and other extensive bedded deposits. Where the reserves were acquired for speculative purposes, this result certainly need cause no public concern, but in some cases it seems to apply to mineral holdings no greater than were thought reasonable at the time of acquisition in order to assure raw materials for the use of associated mills and furnaces. In short, the policy of acquiring reserves necessary for prudent planning of mining operations and for protection of capital investments in the manufacturing based upon them, so generally followed by American industry, may sometimes prove to be an economic impossibility with existing taxation. Already there has been the beginning of a reversal of the process in the cancelation of leases and in default of taxes. Future reversion of reserves to the States on a considerable scale seems not unlikely. It is clear that some of the very large accumulations of reserves under unit commercial control must be either dispersed among many private owners capable jointly of carrying the load or that part at least will have to go back to public ownership.

Because of these conditions there has been a distinctly growing trend among tax specialists and leaders of the mineral industry to question the merits of the ad valorem tax and to favor some form of tax on annual production as a substitute.

Viewed from the broad public interest the major objection to the abandonment of the ad valorem tax is that it would favor the concentration of ownership of mineral reserves in very few hands and hence would put a premium on monopoly. Reserves acquired cheaply in pioneer days, or as an incident to timber or agricultural purchases, or for the purpose of shutting out future competition could be carried indefinitely at very low cost. Huge unearned increments would be enjoyed by a few lucky, shrewd, or unscrupulous individuals. There are occasional companies with holdings sufficient to last them 200 years. Clearly, therefore, the production tax alone will not fully serve the public interest.

Under these circumstances a possible approach to the problem might be found in an effort to adjust ad valorem taxes to a scale which would make it possible for the active mining operations to carry the reserves really necessary for prudent investment in mine plant and yet to discourage accumulation beyond this requirement. One possible solution to be studied would be the reduction or the elimination of the ad valorem tax on reserves held by operating companies in amounts representing a reasonable ratio to their production. For reserves held beyond the ratio set, the ad valorem taxes might be maintained or even increased. This procedure might result in the reversion to the States of many important mineral reserves which cannot be used until the distant future. This reversion might not involve any considerable sacrifice on the part of operating companies, if coupled with some provision for leasing State reserves when needed. The State would suffer a temporary loss of revenue from ad valorem taxes on such excess ores. This loss would be made up by output taxes of one form or another on active mines, reasonable ad valorem taxes on the limited reserves retained by the mining companies, and later might be more than made up by the collection of royalties from the reserves under State ownership.

Whether this suggestion is practicable or not, the problem would seem capable of solution on the basis of the mutual self-interest of the public and of private industry, without the necessity of making arbitrary choice between political theories. In any case, the necessity of the taxing authority to raise the revenues required for public purposes must be admitted.

The full significance of the relation between mineral taxation and the public interest in conservation has just begun to be recognized and has not been the subject of sufficiently detailed examination and discussion to warrant any individual or group in making any recommendation as to public policy. In fact, primary data, needed for careful analysis of many questions involved, have not yet been assembled, and your committee merely calls attention to the problem as one affecting conservation.

We suggest that this subject, as well as that relating to the conservational effect of the Federal income tax, should be studied with a care commensurate with its importance. There is need of a thorough-going analysis of the broad problems of taxation in relation to the wise use of mineral resources, similar to the forest taxation inquiry now being completed by the Forest Service. The study should combine the viewpoints of the mine-taxation specialist, familiar with the practical problems of the mineral industries, and of the independent economist, familiar with the questions of public policy in taxation of other forms of property.

SECTION II
X. SCRAP METALS

One of the factors offsetting depletion of mineral resources, particularly the metallic ores, is the accumulation of a huge working capital of metal, in the form of manufactured goods or of scrap. There are, of course, numerous raw materials of vegetable, and animal origin that are salvaged and used again. The life span between initial use and ultimate destruction of such materials as paper and rubber, however, is characteristically short, whereas that of the more durable metals is characteristically long.

Secondary metals are those recovered from scrap sweepings, skimmings, and drosses. The secondary, metals industry began humbly with the collection of discarded scrap by the junkman. Its development, however, has been rapid, and it is now a well-established industry of vital importance as a source of many products. Secondary supplies of such metals as copper and lead, subject to little or no rust or wear, may be likened to a reservoir upon which future demand may draw whenever prices make collection and reclamation profitable. They serve as a permanent potential supply, supplementing the reserves of the mines. When a country is dependent upon foreign sources for its supply of a given metal, the amount of that metal in use in the country becomes of invaluable service in the event of war. Metals recovered from scrap compete in markets with the output of mines, displace mine sales by the amount of secondary sales, and have a powerful influence on metal prices.

The large return of secondary metal in certain industries has made it possible for some business organizations to supply their needs for raw metal entirely by scrap originating from their own or similar operations. The railways, for example, produce large quantities of ferrous and nonferrous scrap which they sell to dealers or turn in to smelters as part payment for new metal. They also re-use, at shops or plants, quantities of scrap metals such as babbitt, solder, and bronze. In iron and steel manufacture the extensive use of scrap has been an ever-increasing factor in the last quarter century.

The output of secondary copper, however, serves as perhaps the most eloquent example of the inroads secondary metals have made into markets formerly supplied entirely by the mines. In the period 1910–14 secondary copper represented 14 percent of copper produced by mines, whereas in 1929 it was 41 percent of mine output. In 1933, with many mines in the country closed or operating at a low rate, the output of copper from scrap was considerably more than mine production. Unless some new, large use for copper is developed, it is possible that in the not too distant future the annual production of new copper from the mines may be consistently smaller than the tonnage recovered from secondary sources.

Of the more important metals that come back after use as scrap, the United States is self-sufficient within its political boundaries in iron, copper, lead, aluminum, and zinc, but depends on foreign sources almost entirely for tin and nickel.

As already noted, copper is relatively indestructible and consequently a very large percentage of all copper that is mined and put into use comes back on the market later as scrap. There is also a very large return of scrap lead, although a higher percentage of the consumption of lead is dissipated. The rapid growth and present importance of the secondary copper and lead industries are shown by the following comparisons in which the tonnage of secondary metal is expressed as a percentage of the output from virgin ores. Over the period 1910–14 secondary copper and lead were each equal to 14 percent of mine production; by 1924–28 the proportions had increased to 38 and 40 percent, respectively, and again in 1929 to 41 and 48 percent; in 1933 the tonnage of secondary copper reached the astonishing figure of 133 percent of the mine output, closely followed by a recovery of secondary lead equivalent to 82 percent of the virgin mined metal. For zinc, of which a large portion of the uses are dissipative in character, the tonnage recovered from secondary sources has remained comparatively stationary at about 20 percent of the mine output for all periods mentioned except 1933; in the latter year secondary zinc was 23 percent of primary production.

At the present time about 25,000,000 automobiles are equipped with storage batteries, in recent years the most important use of lead. As storage batteries were first used in automobiles about 1911, when automobile production amounted to only 210,000 units, the great increase in demand for lead for battery use is readily seen. When battery demand was first opening up a rapidly growing outlet for lead, it was not realized to

what extent the discarded batteries would return to the market and furnish a fairly constant annual supply of secondary metal competing with primary lead. It has been estimated that as much as 85 percent of the lead used in the manufacture of storage batteries is normally returned to the smelters for reprocessing.

Insofar as the annual domestic recovery of tin from scrap enters the market in competition with primary tin it competes with the product of foreign mines, for the tin output of the United States from domestic ores is negligible. In this case the supply of secondary tin is somewhat of a safeguard to the American consumers of tin. Over the period 1924–28 secondary tin production was 41 percent of the metallic tin imported; in 1929 it amounted to 35 percent, and in 1933 to 31 percent.

That too little consideration has been given in the United States to scrap metals and their bearing on national and international problems, is indicated by the fact that the United States is the only important industrial nation that has no regulatory measures concerning the exportation of scrap. Our exports of scrap furnish some importing countries with a cheap supply of metal, making it possible for them to compete on a favorable basis in the United States' market for fabricated products. The exportation of tin scrap, which assumed comparatively large proportions in 1934, diverts from the secondary plants in the United States a large supply of crude material that they are amply equipped to handle, depletes the reserves of tin-bearing material in the United States, and weakens our bargaining power as regards prices at which new supplies must be purchased.

The subject of scrap is the great blind spot of the world's metal economy. Despite the importance of secondary metals no statistics of an international character can be had. The United States is the only Government compiling figures of secondary metal production. The present annual statistics of the Bureau of Mines should be established on a quarterly or monthly basis and expanded to include stocks and consumption as well as output. This is one of the most constructive steps that could be taken for stabilization of the metal industries. Until the importance of scrap is recognized, effective adjustment of supply and demand in the metal industries will remain difficult or impossible.

SECTION II

XI. USE OF THE STATES' POLICE POWERS FOR CONSERVATION

Up to this point our discussion has dealt primarily with the economic factors that affect conservation; there remains for consideration the possibility of checking the waste of resources due to careless, negligent, or deliberately wasteful exploitation, by use of the legal powers of the States.

The great mineral-producing States should have the deepest interest in preventing waste of the resources which are the basis of their leading industries; otherwise they may find their natural endowment dissipated after it is too late for remedial action. Indiana awoke to the waste of natural gas after much of her original supply had been burned in open flambeaux or blown into the air. Yet the waste of gas in Indiana was small compared with the enormous quantities now being dissipated in the Texas Panhandle, where a billion cubic feet is being blown off daily, with no use made of it except stripping for natural gasoline. In this case the gasoline recovers barely 5 percent of the total energy in the gas and the other 95 percent is simply blown away.

Prevention of this and similar wastes elsewhere is a complex problem. It requires use of the States' police powers. It also requires modifying the present judicial interpretation of the common law which makes oil and gas subject to "the rule of capture" by a statute which will establish the principle of the equitable share in the common reservoir. Difficult as is the problem facing the States, the stakes are worth the effort. The yearly waste of gas in the Panhandle is now sufficient to supply all domestic consumers in the State of Texas for a period of 17 years. It is nearly enough to supply every householder, every store, hotel, and office in the United States now using natural gas for a period of 12 months.

Under the division of labor prevailing under the Federal Constitution, police powers for the direct prevention of waste in mining reside in the States, and the authority of the latter to prescribe regulative measures controlling wasteful practices is clearly established. Laws to prevent the wasteful production of oil, and to less extent of natural gas, in Oklahoma, Texas, Kansas, California, and in other States have received the sanction of the courts. In the case of Oklahoma, Kansas, and Texas, general authority for regulations promoting conservation is included in a statute which empowers some agency, such as a corporation or railroad commission, to prescribe and carry out waste-preventive measures. By specifying the distances between wells, by reducing needless dissipation of gas pressures essential to oil recovery, and by other regulations, this agency proceeds—with some limitations—to curtail wasteful practices in the oil fields.

In approving the constitutionality of the Oklahoma law, the United States Supreme Court said in *Champlin Refining Co.* v. *Corporation Commission of Oklahoma* (286 U. S., 230, 233):

> * * * There was a serious potential overproduction throughout the United States and particularly in the flush and semiflush pools in the Seminole and Oklahoma City fields; that if no curtailment were applied, crude oil for lack of demand would inevitably go into earthern storage and be wasted; that the full potential production exceeded all transportation and marketing facilities and market demands; that accordingly it was necessary, in order to prevent waste, that production of flush and semiflush pools should be restricted * * *.
>
> * * * Land owners do not have absolute title to the gas and oil that may permeate below the surface * * * The right to take and thus to acquire ownership is subject to the reasonable exertion of the power of the State to prevent unnecessary loss, destruction, or waste.

With this background of experience the States clearly have the power to go further in dealing with waste of petroleum and natural gas, and likewise the power to place similar limitations on the waste of other minerals, such as coal, if they desire to do so.

Progress in this direction can go no faster than the development of public opinion in the individual States. Each State is rightly mistress in her own house, and local people have a clear sense of local needs that may not be fully appreciated by a distant Government in Washington. Yet under past conditions of cut-throat competition between one pool or district and another, a single State has often feared to act alone. In the future if mineral producers are encouraged to cooperate in the stabilization of production, the State which husbands its resources will be less exposed to unfair competition from spendthrift neighbor States. This economic stability is a necessary first step, aiding the States to perceive how much their prosperity depends on their mineral endowment, and opens the way to more effective conservation programs.

Many of the States, however, are not greatly concerned, as the resource losses from production wastes

center chiefly in the dozen Commonwealths which dominate the output of coal, oil, and gas. This fact suggests the possibility of joint action by two or more States immediately concerned, through the use of interstate compacts. The six-State compact for the development of the Colorado River illustrates the potentialities of interstate cooperation. Every encouragement should be given to similar collective action by the States to conserve their mineral resources. Thus far, however, attempts to negotiate an interstate compact to prevent excessive production of oil have emphasized the difficulties in applying the compact plan to the mineral field. The task of controlling overproduction in a few of the States is necessarily part of a larger task of balancing total national supply against total national requirements. It is one phase of the problem of economic stability, the solution of which, as we have already indicated, seems to require the assistance of the Federal Government.

The committee does not attempt to discuss the legal powers of the Federal Government to prevent waste, such as the control of development of new oil and gas pools and direct control of production within a State, under the commerce clause or other provisions of the Constitution. It should be noted, however, that such power is incorporated in the Code of Fair Competition for the Petroleum Industry and is the chief basis of the congressional investigation now being conducted. The decision of a case now before the United States Supreme Court, involving the Federal power to regulate production under the Petroleum Code, should shed great light upon the scope of Federal authority in preventing mineral waste.

Our concern here is with the unquestioned authority of the States for action under their police powers and with the great opportunities open to the States to conserve their own resources. A review of State "conservation" laws disclose widely varied concepts. In a few cases mineral conservation comes to the front, but in many others minerals are referred to only incidentally or not at all. There are different concepts of what should be included in mineral conservation, and the meaning of conservation appears to vary from State to State. Here is an opportunity for introducing a broader and more uniform concept of conservation to include all resources. Study of these problems deserves the early attention of State planning boards. The field is one of the most productive they could enter. The Federal Government should be prepared to furnish technical advice, when called upon, in the drafting of legislation by the States, in accord with well-defined objectives and a broad national policy. Where helpful, it should lend encouragement to interstate compacts. It is recommended that the broad aspect of this problem be given continuing attention by the National Resources Board.

SECTION II

XII. THE SCIENTIFIC AND ENGINEERING APPROACH TO CONSERVATION

In all of the conservational steps discussed under the preceding headings, the necessity for scientific research and better engineering practice is implied, but more should be said about this group of conservational activities. In the interest of greater efficiency, which usually means lower cost, private industry in many instances has gone as far in this direction as economic conditions and the limitations of private ownership permit. However, Federal and State Governments have done classical work in this field and should do much more. The obvious needs are:

1. Extension of areal surveys (topographic and geologic mapping) and of specific studies on occurrences and mineral-bearing districts.

With the transition from general or qualitative knowledge of the mineral resources of a region to a precise or quantitative knowledge, there is constantly increasing need for better and more detailed studies of areal geology for which good topographic maps are a prerequisite. Areal geologic studies are an essential foundation to precise determination of the distribution and the quantity and quality of mineral resources.

2. The preparation of much more thorough inventories of mineral reserves than are now available.

Any policy contemplates exact knowledge of the subject dealt with. The availability of mineral resources is determined by the quantities and their distribution, and by the cost of mining, preparation, refining, and transportation to consuming centers, and these costs vary with form, size, grade, and complexity of composition of the deposits. With increasing knowledge and improvements in the technique of discovery and of mining and treatment, periodic revisions of reserve estimates must be made.

3. Fundamental research in geology in order to improve methods of finding new mineral supplies.

Inasmuch as mineral deposits are exhaustible, there is the dual need for a critical examination of their features and of the environment under which they occur; first, that those under exploitation may be recovered fully and efficiently; second, that, so far as possible, these may yield abundant information applicable to the discovery and exploitation of new deposits. Minerals of economic importance occur widely and in diverse associations; practically all geologic processes yield, at one place or another, a concentration of valuable minerals. Experience has shown that there are limits beyond which private industry and even the universities cannot go in observing the facts and determining the laws which control the occurrence of these minerals. The State and Federal Governments have a distinct field of usefulness in this research—a field that has not been and apparently cannot be successfully occupied by any other agency.

4. Improvements in the technique of exploration.

Well-informed persons generally agree that most, if not all, of the large and rich mineral deposits that crop out at the surface in the United States have been found but they also believe that valuable deposits still lie undiscovered beneath the surface and that many of these will be found by methods of examination and testing that are in process of development. Geologic interpretation is constantly becoming more skillful and several of the physical properties of minerals are now the basis of methods used in their detection. These are broadly called geophysical methods. The range of application and usefulness of these methods of search for new mineral deposits have increased greatly during recent years, and, with research, their use can be still further expanded.

5. Improvement in technique of mining and metallurgy.

Progressive exhaustion of the higher-grade mineral resources requires constant improvement in methods of mining, concentrating, and preparing mineral substances for use. As ores become less accessible and of lower grade, improvements are more difficult to attain. Further progress requires more and more research by industry and governmental agencies. Advances in technique resulting from efforts to extract and treat at a profit frequently are wasteful of the country's irreplaceable mineral resources and may be hazardous to the safety and health of the workers in these industries. Therefore, it is essential that the profit-motive research of industry be supplemented by impartial scientific and technologic research by the national and State governments from the viewpoint of conserving mineral resources and increasing efficiency with due regard to

improving safety and health conditions in these industries. Governmental agencies also should conduct pioneering investigations directed toward the application of new discoveries in science to the mineral industries, and they, together with the universities, should provide industry with the fundamental data needed by it for improvement of mining and extraction methods; and, finally, Federal agencies should develop quickly applicable methods for the mining, preparation, and extraction of strategic American minerals not ordinarily mined for use in event of war.

6. Studies of changes resulting from improvement in transportation.

Many transportation projects should be given special study in relation to possible future movements of mineral traffic. The St. Lawrence waterway project raises several important questions of mineral traffic.

These activities will require the strengthening of organized research through Federal and State agencies, but in addition, will require the coordination of public and private investigation and education and the exchange of information.

SECTION II
XIII. HEALTH AND SAFETY

Mining has long been known as an occupation more hazardous to life and limb than almost any other major industrial pursuit and in many of its phases harmful health conditions are also encountered.

The miner carries on his occupation underground in confined places where it is difficult to maintain adequate lighting. Frequently the rock stratum overhead requires much care to prevent its crashing down on the worker who must be on the alert also to avoid relatively small rock falls that often occur without warning. Powerful explosives—with all the risks that accompany their use—and machinery, operated under conditions usually much more hazardous than on the surface, have a regular place in the daily tasks; in addition, some mines give off explosive or irrespirable gases or may be subject to intrusion of dangerously large volumes of water. Rock falls, fires, explosions, asphyxiation, and machines take a large yearly toll in human lives and crippled bodies. Recent statistics compiled by the National Safety Council indicate that mining has much the highest accident rate, both in frequency and in severity, of all major industrial occupations. Moreover, we are the most backward major industrial nation in the matter of mine accident prevention, for the accident rate of the United States is exceeded only by that of Chile.

Prevention of accidents in the mining industry is a far more complicated problem than in surface industrial work, even of the more hazardous types, because the different elements which enter into possible accident hazards are much more readily ascertained above ground and action can be taken against them; also, errors in judgment causing accidents in surface industrial work usually affect but one or possibly a few persons, while in mines a human error may readily cause an explosion or other occurrence that may result in death for scores or even hundreds of persons.

In addition to the accident risk, various conditions in and around mines, usually in connection with the air which the worker breathes, have an adverse effect on health. Many deep mines have high temperatures, others have both high temperatures and high humidities, and some shallow mines are affected by outside climatic conditions. Some mines have harmful waters or gases while others are afflicted with dusts. Dust disease is the greatest health menace to the miner, whether in coal or in metal mines, and it is probable that more underground workers are incapacitated or die from breathing excessive amounts of dust than are killed by mine explosions and fires. While health is the greatest asset of any human being, it is of greater relative value to the miner because his occupation demands the possession of far more than ordinary endurance and command of faculties.

The sheer human tragedy of mine disasters with their heavy loss of life is the overwhelming case for an effective mine safety program. Those who have seen the anguish in the faces of relatives stolidly waiting at the tipple for news of husbands and brothers entombed below know the urgency of adequate Federal efforts to reduce the human toll of the mines.

The immediate effect of accident and ill health is cessation or curtailment of income with consequent economic distress in the worker's family and additional strain on relief agencies. The average age of the coal-mine worker who is killed is 35 years, and his active life expectancy and potential income would be relatively good in most other industries. Miners and their families lose between $50,000,000 and $100,000,000 in income annually due to preventable accidents and ill health. While compensation payments may be received by the victims or their dependents as a temporary aid, in general the families of the sickly, crippled, or killed miners usually become largely dependent upon the public for support for several years after an accident, sometimes indefinitely.

Aside from the question of conserving human life and preventing suffering, mine accidents and unhealthful conditions increase the cost of producing mineral raw materials. Recent data indicate that 10 or more percent of the mine cost of producing coal or ore is due to various factors entering into accident occurrence; in the bituminous coal industry alone this amounts to between $30,000,000 and $50,000,000 per year. If already known and available improved safety methods and measures could be put into general use, the burden of accident expense could probably be reduced to as low as 1 or 2 percent of mineral production costs. The investment of a small fraction of the annual losses in workers' income and the increased mine costs in a

larger program to curtail preventable accidents and ill health holds possibilities of at least a hundredfold return.

The difficulty in preventing accidents in and around the mines is well known and most countries have rather rigid regulations protecting the safety, and to a much less extent the health, of the workers in mining and allied industries. In the United States the Federal Government, through the Bureau of Mines, has led the mine safety campaign through extensive educative and cooperative safety programs, by training hundreds of thousands of miners in safety and first-aid practices, by the indirect improvement of mine machinery to exclude unsafe features, and by constant investigations and research to point the way to improved safety practices. Under the Constitution, however, the authority for enforcement of specific safety measures at individual properties resides with the States, and most mining States have laws and agencies intended for safety promotion and enforcement. The State laws and regulations are usually a skeletonized outline of some of the fundamental minimum safety requirements and are often too general in nature to give adequate protection to the mine worker or even to the mine in terms of modern standards.

For many years progressive mining companies have not been satisfied to operate only within the meager safety requirements of the State codes and have adopted additional and more effective safety procedure of their own, although complying also with the State rules. As a result of this forward-looking policy, many of these companies have made great progress in the reduction of accidents. Many examples could be given of such laudable special safety efforts by companies in all branches of the mineral industry, including bituminous and anthracite coal mines, metal mines, nonmetallic mineral mines, coking plants, milling, smelting, and metallurgical establishments, and the various activities in connection with the production and processing of petroleum.

Over a period of 23 years the threefold cooperative efforts of mining companies, the States, and the Federal Government have saved the lives of 24,300 coal miners and eliminated 50,000 annual nonfatal accidents. Organized safety work received its impetus following the 5-year period 1906–10 when there were 84 major coal mine disasters and when coal mine fatalities reached the shocking total of 13,288, or a fatality of 5.89 persons killed per million tons of coal produced. Congress reacted to this situation by establishing the Bureau of Mines in 1910 which has constantly led the pioneer work on behalf of greater mine safety. The success of this movement can be measured by the decline of the coal mine fatality rate from the high levels of 1906–10 to 3.31 accidental deaths per million tons of coal produced in 1931, 3.36 in 1932 and to 2.69 deaths (preliminary figure) in 1933. If the 5.89 fatality rate for the early period had continued to the first of January 1934, the lives lost would have been 24,300 more than the number recorded. Similar figures as to prevention of nonfatal accidents are not available, but it is estimated that there are about 50 nonfatal accidents to 1 fatality and that about 50,000 nonfatal accidents a year have been avoided.

While much progress has been made in the operation of mines with lessened loss of life or limb, especially in the last decade, consistently exceptional safety performance at many operations indicates that there is still much to be done toward raising the general standard. Some mines, for example, have worked 25 or more years without a fatal accident while others have worked large numbers of men a year or more without the occurrence of a lost-time accident; one surface mining operation produced upwards of 75,000,000 tons of rock without a fatality and another underground mine produced over 15,000,000 tons of ore without a fatality; in numerous instances individuals have worked 50 or more years in mines without having sustained any accident which would prevent their working at their jobs on the next regular shift. Recent statistics show that approximately 70 percent of the mines of the United States operate without fatalities, and it is probable that at least 75 percent of the nonfatal accidents occur in 25 to 30 percent of our mines. Unquestionably, some managers now know how to hold accident occurrence to a minimum, and in so doing reap a financial reward as well as performing a humanitarian service of the highest order. Observers who have given the closest study to the subject of accident prevention in mining are thoroughly convinced that accident occurrence can be reduced at least 50 percent (possibly as much as 75 percent) from present rates if the necessary effort is made.

Research in health and safety in mining is needed now more urgently than in any other period of our mining history, as mine technology is subject to rapid changes that invariably introduce new elements (often unfavorable) affecting the health and safety of the workers. Unless study and research on these problems are continuous, little understood conditions are likely to endanger further the life of the miner. Dust diseases, particularly, are increasing and require study of causes and development of methods that will eradicate, or at least materially lessen, their effects. Air conditioning, now beginning to be utilized in other in-

dustries, calls for research in its application to the comfort, health, and safety of the mine worker; very probably its application will be found to be connected with the ventilation problem which in some form or other confronts every mine.

Knowledge of how to avoid the special hazards of the mine is not in itself enough; special efforts must be taken to make this information effective by constant education and reeducation of the operator and mine laborer. The ordinary mine worker reads but little and remains in ignorance of surrounding risks unless some central educational agency, capable of successfully reaching into hundreds of widely scattered mining camps throughout the country, is kept functioning. Education is also needed to promote closer correlation of State laws and regulations on mine safety, as well as to point out any inadequacies in present codes.

The need for accident and health work in mines is urgent and ever pressing. The responsibility for leadership in the effort to reduce unnecessary deaths and suffering rests on the Federal Government. Neither depression nor prosperity can change the need or the responsibility; and an aggressive, effective long-time mine safety program must function continuously, especially in maintaining frequent contacts with the mine worker. It is the judgment of the committee that reduction of field safety and health work in mining by the Federal Government is false economy threatening the entire mine safety program which must not be allowed to fail.

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SECTION II

XIV. FEDERAL AGENCIES OF MINERAL ADMINISTRATION

Any attempt to carry through a national policy for the conservation of minerals will involve some readjustment and extension of the present official agencies. At present the field is divided somewhat as follows:

1. The scientific, technical, and statistical services are performed mainly by the United States Geological Survey and Bureau of Mines, both of the Interior Department. The Geological Survey conducts fundamental studies in geology including all mineral resources, many of which bear directly upon the classification of the public domain, makes inventories of mineral occurrences, and estimates reserves. The Survey prepares topographic and geologic maps, studies surface and ground water resources, and through its conservation branch has charge of the leasing of minerals on the public lands.

The Bureau of Mines is mainly responsible for studies of methods for extraction and use of minerals, geophysical methods of prospecting, safety and health of miners, statistical information services, and research in the underlying problems of mineral economics.

2. Foreign aspects of the mineral problem are considered by the economic division of the State Department, by the Export and Import Bank; by the Bureau of Foreign and Domestic Commerce in the Commerce Department; by the Tariff Commission; and by the raw materials committee of the War Department.

3. The Bureau of the Census collects some mineral statistics, particularly as related to smelting, refining, and the burning of cement, lime, gypsum, and clay.

4. The administration of mineral codes of fair competition rests with the National Recovery Administration, except for petroleum which is administered by the Petroleum Administrative Board under the Secretary of the Interior.

At present no one of these agencies has the authority or the personnel to consider all phases of the mineral problem and to bring about effective coordination of any national policy of conservation.

At the request of the Secretary of the Interior, the Science Advisory Board has submitted reports on the United States Geological Survey, on the United States Bureau of Mines, and on the reorganization of the statistical and economic work now divided among several organizations—the Bureau of Mines, Geological Survey, Bureau of Foreign and Domestic Commerce, Bureau of the Census, and others. Various recommendations have been made in the way of reclassification of the services of the different bureaus, the elimination of some phases of the work, and the strengthening of others. It does not seem necessary to repeat these recommendations in the present report.

However, these minor shifts are not sufficient for a concerted attack on the problem of mineral conservation. There remains to be settled the question of where the administration of codes and production controls involving minerals shall be lodged in the future and their relationship to existing agencies. There is also the problem of how all of these activities shall be coordinated and by whom.

Your committee is not now ready to make specific recommendations on these questions of organization, though we have in mind certain general principles upon which such organization should be based. It seems to us that the principal scientific, technical, and statistical services should remain where they are in the Department of the Interior where public lands are administered. This group of agencies has been in the past, and should continue to be, the central research and fact-finding group for the mineral industries. Some of the fact-finding activities of other departments, such as those in the Minerals Division of the Bureau of Foreign and Domestic Commerce, should be transferred to the Interior Department. The Departments of State, Commerce, and War, and doubtless other Government agencies, will continue to deal with special phases of mineral trade and, in some instances, may require the services of full-time mineral specialists. In general, however, the committee feels that the needs of these agencies can best be served by developing close working contacts with the central fact-finding services in the Department of the Interior. Provision should be made for investigations abroad by men trained in mineral economics and technology, studying special problems of interest to the domestic mineral industries.

The fact-finding services should be under separate direction from the actual administration of mineral codes or production controls, in order to insure independence of scientific inquiry, yet so oriented as to be of maximum assistance in supplying the data needed for code administration.

Supervision of mineral codes involving control of production, as recommended in our consideration of the subject, should ultimately be grouped under one agency.

There are problems of wasteful competition between the mineral industries as well as within them which involve administrative cooperation. Action under an oil code may vitally affect a bituminous coal code, and vice versa. Doubtless the present division of the codes between the National Recovery Administration and the Petroleum Administrative Board of the Interior Department may well continue until the expiration of the Recovery Act in June 1935. Thereafter, the decision will be largely governed by the extent to which the functions of the National Recovery Administration may be permanently continued. If it is desired to place all Government supervision of industry under a single agency, emphasizing uniformity of labor standards and trade practices, the mineral codes might be grouped under a minerals division of a permanent National Recovery Administration. If, on the other hand, it is desired to emphasize the distinctive problems of resource utilization (and the relation of production control to conservation), the mineral codes might be grouped under a mineral-industry division of the Department of the Interior. The latter arrangement has the advantage from the conservation viewpoint of permitting the fullest use of the geologic and technical services and of coordinating the operations of production control with administration of the public domain. Even should Congress consider separate enactments authorizing control of production by the coal and oil industries, it would be well to correlate their administration with other services touching the minerals as a whole.

If reorganization follows these general lines, the Secretary of the Interior would be the Cabinet member having the principal responsibility of mineral administration, and to this extent will be the principal coordinating authority. In addition, however, it would seem necessary to provide for an advisory coordinating committee made up of representatives of all the agencies of mineral administration both within and without the Interior Department, and for a representative of this committee on any more general natural resources coordinating committee that may be set up under the National Resources Board or elsewhere.

We wish to stress the fact that the support of the mineral services is utterly inadequate for the work to be done. Not only has it been impossible to take on important new problems required by changing conditions, but some of the fundamental services which have been long established and have proven their worth have been greatly impaired by recent cuts in budgets. Even such elementary service as the collection of primary statistics of production, which has been a Government function for 50 years, can no longer be adequately performed. Such figures are basic to the intelligent formulation of either emergency or long-range plans. Because of this lack, statistical services have had to be improvised by the National Recovery Administration and other emergency organizations, and the continuity of record is being destroyed.

The exhaustibility of minerals warrants special emphasis on scientific and technological investigations by the Government. The value of minerals produced annually is about 50 percent of that of agricultural products derived from the soil. Notwithstanding the importance of the mineral problem to our national welfare in comparison with agriculture, the total appropriations for Government mineral services are only a fiftieth part of the appropriations given to similar scientific and technological services in agriculture. Minerals, in short, from the standpoint of public attention have been a neglected natural resource.

PART IV—SECTION III
INTERNATIONAL ASPECTS OF MINERAL POLICY

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SECTION III
INTERNATIONAL ASPECTS OF MINERAL POLICY

I. Introductory Statement

Mineral reserves are unequally distributed among the nations. The principal world production is grouped around the North Atlantic, though important supplies exist elsewhere. No one nation has a complete supply of the minerals necessary for modern industry; specialization, reciprocity, and large-scale movements between the nations arise from in nature's unequal distribution of them. The principal sources of supply are relatively few as compared with the nations to be served—a fact that determines broadly certain natural outlines of the world flow. The world supplies of most minerals are so large that there is little need for concern about early exhaustion; but for each nation there is danger of early exhaustion of particular minerals; and all nations are concerned in the tendency of depletion to force an increase in cost, unless the growing difficulties of nature can be offset by new discoveries, cheaper transport, or advances in mineral technology.

The orderly development of these resources of the world by persons qualified by knowledge, skill, and financial strength, and the natural movement of raw materials to the centers of consumption are being somewhat impeded by a great variety of national restrictions on development, on importation, and in a few instances on exportation. Natural channels of the international flow of minerals are being deflected, with great losses to established trade and plants. In some countries high-cost and marginal units of industry not justified by the law of supply and demand are coming into existence, supported for reasons of national defense, or because of a forced or freely undertaken effort to achieve national self-sufficiency. Large world surpluses of mineral production and refining capacity are thus being created, which must be taken into account in solving domestic surplus problems. The world's few rich supplies are not being used most efficiently as cheap sources of raw materials, while the artificial stimulation of new mine capacity, displacing capacity already in existence, forces the resource waste which we have seen to be associated with premature abandonment.

The present strong trend toward nationalism and closed doors in the mineral field is the result of the natural desire for economic self-sufficiency, for self-determination, and for defense. Another compelling force has been the effort to protect currencies and international trade positions. In the present state of world affairs, perhaps the dominant motive of nationalism is fear of extortionate prices, or of being cut off from supplies, in time of war. Economic nationalism may be a conscious public policy based on political considerations or it may be merely the result of activities of special commercial groups; usually it is some combination of the two.

The accompanying chart presents a clear picture of the principal minerals which must figure in international trade either because they are pushed out by the pressure of surplus or must come in owing to a complete or partial lack of local supply. It shows for the principal minerals and for the principal industrial countries the real interdependence of nations in regard to mineral supplies.

The primary objectives of any foreign mineral policy of the United States are obviously (1) to facilitate imports, at low cost, of minerals not produced in the United States in sufficient abundance or proper grade to supply domestic needs, and (2) to secure markets for the few minerals existing in large quantities in the United States and efficiently produced in excess of its own requirements.

II. Foreign Trade in Minerals With Exportable Surplus

Looking forward to the long life of a nation, it is doubtful whether any of our minerals can be said to exist in surplus amounts and, therefore, any long range national policy should not permanently include the encouragement of mineral exports. However, for some of our minerals, the reserves are so large as to give little concern about shortage for many decades; and capacity for production is so large that there is pressure for export. Also, in some cases there is a demand from nations lacking these resources, which ought to be met in the interest of maintaining something like equality of economic opportunity among nations, just as we expect fair recognition of our own needs of foreign supplies. The exportation of certain mineral products of the United States will almost certainly persist for some time, though the committee sees no justification for artificial stimulation.

Sound policy in regard to the exportation of such American mineral products as may find place in a competitive world market, without endangering the

INDICATED ABILITY OF THE PRINCIPAL CONSUMING COUNTRIES TO SUPPLY THEIR NEEDS OF THE PRINCIPAL INDUSTRIAL MINERALS

⊡ FROM WITHIN THE POLITICAL BOUNDARIES OF THE HOME COUNTRY.
⊠ FROM SOURCES EITHER POLITICALLY OR COMMERCIALLY CONTROLLED BY THEM.

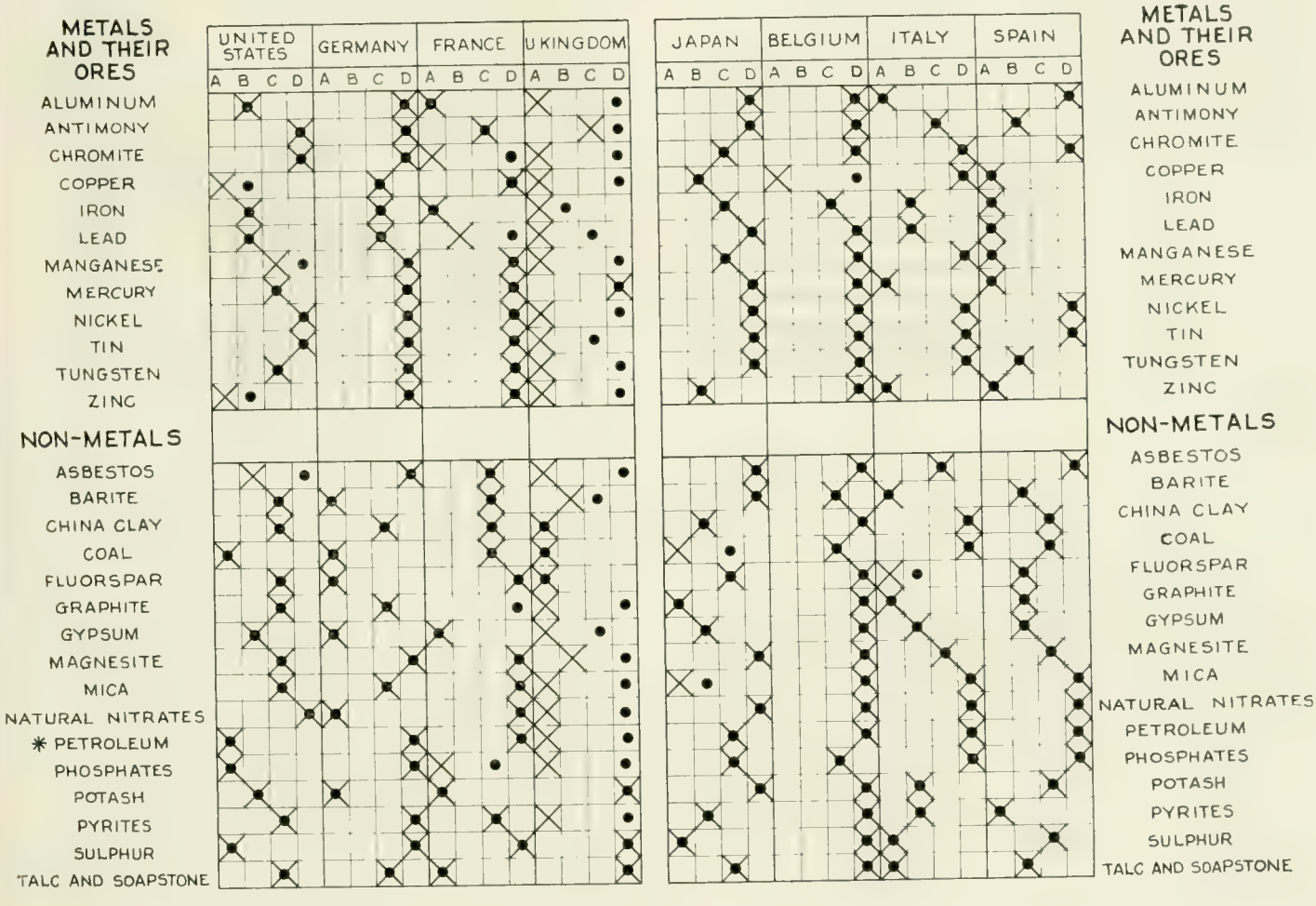

CHART 1

A-MINERALS AVAILABLE FOR EXPORT.
B-MINERALS ADEQUATE TO MEET DOMESTIC DEMANDS WITHOUT APPRECIABLE EXCESS OR DEFICIENCY.
C-MINERALS INADEQUATE TO MEET DOMESTIC DEMANDS, OR SO LOCATED OR OF SUCH GRADE AS TO REQUIRE DRAFT ON FOREIGN SOURCES.
D-MINERALS FOR WHICH THE COUNTRY DEPENDS ALMOST ENTIRELY ON FOREIGN SOURCES.
*-EXPORTABLE SURPLUS PROBABLY TEMPORARY

PREPARED BY
MINERALS DIVISION
BUREAU OF FOREIGN AND DOMESTIC COMMERCE
June 1, 1934

supply required for domestic needs might well include the following:

(1) Give them fair place in the program of negotiation of commercial agreements.

(2) Seek to secure for them, as for other American products, fair tariff and trade treatment by foreign governments.

(3) Maintain the Webb-Pomerene Act allowing combination of activities in export trade.

(4) Permit American participation when desired in international cartels (sulphur, phosphate, nonferrous metal, etc.), with suitable safeguards of public supervision, particularly as to price.

(5) Avoid artificial stimulation by special concessions in freight rates or shipping subsidies not extended to other commodities.

(6) Discourage importations which aggravate anti-conservational conditions of surplus development. The effect of cessation of imports on refining capacity, especially where there is already excess capacity, as in oil and copper.

III. Foreign Trade in Minerals for Which The United States Depends Partly or Wholly on Outside Sources

Dependence upon foreign sources may be due to deficiency in total domestic supply, to shortage of desirable grades, to disadvantageous location of supplies in relation to market.

In commercial and financial negotiations, American representatives should keep in mind our need for specific minerals from specific countries, as shown in the following table:

Mineral commodities in which the United States is wholly or partly deficient and principal foreign sources of supply

Commodity	Principal sources	Alternate sources
Antimony	China	Mexico.
Asbestos	Canada	Rhodesia, Union of South Africa, Russia.
Barite	Germany	Netherlands.
Bauxite	Surinam	British Guiana.
China clay	Great Britain	
Chromite	Rhodesia	Greece, French Oceania, Cuba, Portuguese Africa, Turkey.
Fluorspar	Germany	France, Spain.
Graphite[1]	Madagascar	Ceylon.
Magnesite	Austria	Czechoslovakia, Russia.
Manganese	Russia	Brazil, India, Gold Coast, Cuba.
Mercury	Spain	Italy.
Mica[1]	India	Canada, Madagascar.
Nickel	Canada	New Caledonia.
Nitrates, natural	Chile	
Pyrites	Spain	Canada.
Talc[1]	Italy	France, Canada.
Tin	Malaya	Hong Kong, Netherlands, United Kingdom.
Tungsten	China	Bolivia, Burma.

[1] Adequate reserves of these materials exist in the United States but their location with reference to the centers of consumption is disadvantageous or their grades are not fully adopted to our uses.

[2] The domestic requirements for nitrate can be met entirely by synthetic production if necessary.

This group of minerals is the one primarily to be considered in reciprocal tariff discussions and other attempts to facilitate foreign trade.

For the group as a whole a reasonable policy would seem to include the following:

(1) Consideration of tariffs in the light of the extent, grade, location, and future life of domestic resources. The group includes several minerals raising debatable problems of tariff revision, such as mercury, tungsten, manganese, graphite, mica, and magnesite.

(2) Protection of American interests against any attempts to maintain excessive prices on our needed imports through the operation of cartels and intergovernmental agreements, export duties, or other restrictions on exports to the United States.

As regards the few minerals vital for national defense purposes, consideration should be given to

(3) Restriction or regulation of export of scrap.

(4) Establishment of special reserves as discussed in IV of Section III.

(5) Maintenance of trading lines carrying these minerals.

It will be noted that the list of minerals for which we are wholly or partly dependent on foreign sources includes several which are also found in large quantities in the United States. There are cases where the domestic deposits, though of adequate size and suitable grade, are remote from centers of consumption, and where foreign supplies, moving on low ocean freight rates, can be laid down in the coastal areas at much lower cost than domestic supplies. A familiar example is magnesite. There are other cases, where the domestic deposits do not yield all of the special grades obtainable from abroad. A familiar example is china clay. In either situation a complete stoppage of imports would heavily penalize consumers in some areas.

IV. National Defense and Imported Minerals

The United States approaches self-sufficiency in its domestic supplies of minerals important for national defense more nearly than any other country. Furthermore, substitutes could be developed for many uses of almost all strategic minerals. In a national emergency, however, the limited domestic supplies would have to be supplemented in the case of manganese, chromium, tungsten, nickel, and tin. Mica and mercury also might present a problem.

These mineral raw materials are necessary for a balanced industrial production in peace time, and they become vitally essential in time of war. Other nations, less fortunate than we in their endowment of national resources, have been trying to guard their position. For example, France requires importers of nitrates to keep a 3 months' supply in stock, has forced the erection of petroleum refineries through her oil import regulations, and there is reason to believe that Great Britain, Russia,

Japan, Germany, and France have all imported raw materials for making ferro-alloys in quantities beyond the normal requirements. The United States has taken no direct precautionary steps to assure itself in a similar way.

This country cannot afford to risk the danger of an interruption of the steady flow of these supplies in an emergency. At such a time, if we should continue to depend on importations, part of the Navy would have to be diverted from combat duty to convoy service, patrolling the sea lanes along which cargoes of these materials would move. Reliance must rather be placed on stocks existing within the country plus possible domestic production. Therefore, to prevent enforced shortages of these essential materials in times of stress, any long-range planning by the Federal Government should include the maintenance of stocks adequate to meet emergency requirements. Our relative dependence on foreign sources for each of these critical materials is indicated in the following paragraphs:

The average domestic production of metallurgical manganese ore during the past decade has been approximately 10 percent of the total national consumption. In 1918 under the intense stimulus of high prices, about 300,000 tons of metallurgical manganese ore were produced in the United States, less than one-half of the normal yearly requirements. Since the war, tariffs have been levied on the importation of manganese ore in the hope of developing a domestic industry. Although the tariff rate of metallurgical ore is equivalent to 100 percent ad valorem, the results have been disappointing. We do not have adequate domestic supplies.

Practically all of the chromium ore for meeting the domestic needs is obtained in normal times from Rhodesia and Cuba, but it is estimated that in an emergency the United States could produce between 25 and 30 percent of its requirements. It is doubtful if Cuba could make good our domestic deficiency, even at very high prices, and adequate supplies would depend upon open lanes across the Atlantic.

China normally provides about 75 percent of the tungsten ore consumed in this country, although under the stimulus of war-time needs the United States may procure approximately one-half of its needs from domestic sources but then only at a very high cost. Alternate sources are located in Bolivia and Burma, but obviously the strategical advantages of these sources are slight.

Antimonial lead from domestic sources might supply one-half of our needs of antimony in times of stress, but under ordinary circumstances China satisfies 75 to 80 percent of our demand for metallic antimony. There is a possibility that some antimony ore might be imported from Mexico in war times without the hazard of marine transportation, but even then the solution of the problem would not be complete.

No tin is produced within the United States but with severe restriction of civilian uses the recovery from secondary sources might supply 30 percent of our war-time requirements. Tin ore is produced principally in British Malaya, Bolivia, and Netherland East Indies. No tin ore is now smelted in the United States, and more than one-half of the world's supply of metallic tin is produced in the Straits Settlements, more than one-fourth in England, and most of the remainder in Netherland East Indies. Closed sea lanes would completely shut off our supplies of this metal.

There are no primary sources of nickel in this country, and the amount of metal recovered as a byproduct or as secondary material is inconsequential. We depend almost entirely on Canada, the source of about 90 percent of the world's supply.

Under the stimulus of war demand, most of our requirements for mercury and mica could be met by domestic production. The deficit in mercury might be met by the output from Mexico. In the case of mica, however, it appears that the needs for special electrical uses can be supplied only by importations from India.

Many studies have been made concerning these minerals in which our domestic supply is insufficient, and many measures have been proposed as to how the situation might be met. But *assurance* of an adequate supply of certain of these minerals in war can be obtained best by providing physical, stock-pile reserves. For several of the minerals tariff protection has been used to stimulate domestic production but has, in general, failed in its object. Domestic production has not been sufficiently stimulated to give an assurance of an adequate supply.

Government stock pile reserves may be obtained by one or a combination of several methods:

1. By direct purchase in domestic and world markets.

2. By accepting materials in lieu of tariff-duty payments.

3. By accepting materials in partial payment of war debts.

4. By using emergency relief funds to stimulate domestic mining.

The first method, of direct purchase, is the simplest and quickest way to attain security. It would entail the expenditure of large sums, available only through direct appropriation by Congress. The cost, however, would be a small fraction of present annual appropriations for defense. In the event of a major war the investment would repay itself many times over.

The second method, of accepting tariffs in kind, might be looked on with more favor, as it would avoid the necessity of direct appropriation. The net effect, however, would be much the same, as the Treasury would be deprived of tariff revenues which it now receives. Undoubtedly such a plan would be opposed by the consumers of these materials, particularly if it should involve new tariffs on minerals that now enter free of duty.

The acceptance of materials for part payment of the war debts, now largely in default, appears as a possible method of securing needed reserves. Debtor nations reason that, lacking sufficient gold to make the payments due, they must pay in goods. Much of their goods competes directly with the products of our mines, fields, and factories. If, however, reasonable quantities of the minerals discussed above were accepted in part payment of war debts, and were then placed in a Government reserve, there would be no injurious effect on our industries. The supplies might come from stocks already above ground or new production. If the debtor governments were to acquire these minerals and transfer them to the United States, the stocks which now overload the world market and constitute a threat to the price structure, and fears that they might be dumped on the world market, to bring whatever might be offered, would no longer exist. Industry throughout the world would then feel the stimulus of demand for new stocks.

Under present unemployment conditions, when millions of dollars are being spent weekly for relief, consideration might be given to having some of the unemployed do useful work in mining ferro-grade manganese ore, chromium ore, tungsten ore, quicksilver, and mica, and placing the products in reserve against war requirements. This proposal has the grave defect of stimulating mineral development beyond the point that could be sustained under normal competitive conditions. On withdrawal of the artificial stimulus, domestic production would decrease, unemployment would again increase, the Nation would have something of value in the ores produced, but the best of its limited reserves below ground would be severely depleted.

The estimated war needs for two years are:

	Short tons
50 percent ferro-manganese ore	1, 000, 000
50 percent chromite ore	300, 000
Metallic tin	60, 000
48 percent tungsten ore	10, 000
Antimony	35, 000
Nickel	40, 000
Mica (sheets and splittings)	3, 000
Quicksilver (flasks, 75 pounds each)	25, 000

It may be stated that the above quantities do not in general exceed the total importation of these materials in the year 1929. Any plan for stock-pile reserves should provide for the cost of secure and permanent storage facilities. Stock-pile reserves should be held inviolate until actually required for war needs. Under these conditions they would have no adverse effect upon peace-time markets.

In addition to stock piles to be held by the Government, consideration should be given to prohibiting the export of scrap of those metals for which the United States depends largely on foreign sources. America is the only industrial Nation that does not regulate the export of scrap of strategic metals.

National planning should take the long-range view. The Nation should seek to provide against emergencies that might threaten its existence, in the same way that business organizations protect themselves by insuring their property against fire and theft. Stocks of the strategic minerals are an elementary form of national insurance. Without raw materials, the industrial front crumbles, and the Nation cannot maintain its armies in the field.

V. Tariffs

Tariff questions arising in connection with some of the minerals have been briefly referred to in II of Section III. Some further general observations on the nature of tariff policy in the mineral field may be in point.

It is sound and wise American policy to give reasonable protection to those branches of the American mineral industry which have adequate deposits available at reasonable prices.

Those minerals, however, of which the United States lacks adequate supplies, either in general or in certain grades, present a somewhat different problem. Efforts to develop local supplies by levying tariffs on importation and raising domestic prices have had little success. So far as they have increased production, it has been at high cost and has added to the world surplus of production capacity and has depleted our limited supplies which should be held for emergency. Importation from the great supplies of high-grade ores existing in foreign countries continue despite the tariffs. Enlightened self-interest would seem to call for a frank recognition of this situation created by nature. We suggest study of the question whether tariffs on some of these minerals may be advantageously reduced or rescinded, in return for trading advantages from the countries controlling these supplies.

It would also seem likely that in regard to some of the minerals, the interests of this country could best be served by a somewhat more selective type of trade control arrangement than our present tariff. For example, in the field of petroleum it would appear to be desirable to work out arrangements which while protecting domestic industry would still make place in our market for supplies of certain grades which are complementary

to American production. If tariffs have tended to check the flow of raw materials into this country attempts should be made to devise satisfactory arrangements whereunder foreign supplies may be more conveniently available to the American refining industry which serves export markets. Arrangements of this type would, for one thing, better serve conservational interests.

Other aspects of this question which merit consideration are (*a*) whether in the case of some minerals, the problem of foreign competition cannot be most suitably handled by some form of quantitative restriction, (*b*) whether in certain fields the Government would not be warranted in giving direct subsidy or bounty to encourage domestic production. In this report we are not prepared to recommend specific measures of this kind but believe them important enough to merit further attention.

The foregoing observations apply to instances where tariffs are imposed primarily for the purpose of protecting American production. If it is desirable to consider tariffs on mineral products for revenue purposes the obvious course of action is to put a high rate on those commodities that are not produced in the United States, lower rates on those of which part of the demand is met from domestic production, and of course not any tariff on commodities not imported in sufficient quantities to yield appreciable revenue.

VI. International Cartels and Agreements

There exist a number of agreements with respect to minerals which cross national lines and which exercise a considerable control of the production and marketing of these minerals. In some instances, these are primarily agreements between the producers, and they create in some respects an international trust or monopoly. In other instances, the governments of producing countries have become parties to the agreement and lend their authority to the measures of restriction and control which have been initiated.

A certain amount of unified commercial control, international in scope, is a natural consequence of the limited number of large sources of supply. For some minerals there is already an approach to world monopoly by single companies or cooperating groups of companies or cartels, as illustrated by nickel, vanadium, aluminum, potash, asbestos, mercury, sulphur, natural nitrates, bismuth, and diamonds. For others ownership is more divided, but still in sufficiently few hands to make world cooperation potentially possible. In this category may be mentioned copper, iron, lead, oil, tin, and manganese. International combinations which can be classed as cartels have from time to time been formed for raw steel, zinc, copper, pig iron, sulphur, ferromanganese, aluminum, lead, mercury, diamonds, magnesite, nitrogenous fertilizers, tin, and other semi-fabricated and manufactured commodities such as steel rails and tubes, portland cement, etc.

When, through a fortunate combination of raw materials, demand, competent management, and adequate capital, a thriving mineral industry develops, it is likely to become the center of an ever-widening sphere of commercial influence reaching farther and farther afield for new supplies, and eventually transcending national boundaries. In time its sphere impinges on that of other growing units, with the not uncommon sequence of intensified competition, cooperation, and finally, merger. Unification has usually brought conservational advances in production, manufacturing, and distribution, although frequently higher prices to the consumer at the same time. The growth of a large unit puts smaller scattered competitors in such a disadvantageous position that they are more or less compelled to combine as a defensive measure. Concentration of commercial control has already tied up so much of the world's mineral resources that the possibilities for acquisition of reserves by new purchasers are very limited. On the other hand, there is a growing surplus of current production and capacity for production for most minerals. One of the purposes of commercial unification is the more intelligent handling of this surplus.

The international spread of unit control has been hindered and deflected by various political measures designed to preserve the local control over domestic industries. Tariffs and taxes have been freely used as defensive measures against outside commercial control. When the barriers thus set up become too high, the outside owner often finds it necessary to form separate companies and to build up local mining, smelting, or manufacturing to a greater extent than might be necessary or desirable if the political barriers did not exist. Nevertheless, there is a steady trend toward common ownership and centralized direction of the industry.

Generally speaking your committee believes that a considerable degree of cooperative action among mineral producers in different countries is desirable and that it should be encouraged rather than hindered by the Government as a means of combating the present trend toward exaggerated economic nationalism. It offers a means of balancing world production with consumption, insuring that the cheapest and best-located supplies are drawn on, limiting overdevelopment of low-grade marginal enterprises which can yield supplies only at high cost, and insuring orderly distribution and marketing. However, it is essential that consuming interests be adequately protected. This might be achieved by giving these interests effective representation in the operation of international agreements, and by the practice of full publicity.

Competition from marginal sources will in many fields be a brake upon excessive prices, and if necessary this can be encouraged by political measures designed to promote development of local supplies. The responsibility of curbing abuses of power will obviously fall on the stronger nations with potential supplies. The elimination of selfishness in such control is probably impossible, but at least it is an objective to be striven for. If, for instance, the parties to the international tin agreement use their power to secure unreasonable prices, it should be a matter of definite public policy in any nation to encourage exploration and development of new reserves and the development of substitutes. The success of this effort being very unlikely for the near future at least, the Government might resort to other defensive measures, such as reciprocal tariffs and trades for other commodities, in order to keep tin prices within reasonable limits. It happens that tin is one of the most sparsely distributed natural resources, so far found in commercial quantities in only a few parts of the world. For most of the other commercial minerals there are far greater possibilities of control through competition of new supplies.

Executive members of the International Tin Committee are representatives of the several governments and as such act as government agents in the administration of the tin cartel. Although to date only producing countries have been represented, the Committee announced recently that it will appoint an Advisory Panel of representatives of the private consuming interests of the major consuming nations. Such a plan apparently follows that instituted by the International Rubber Regulation Committee, however, providing no vote for members of the Advisory Panel, and leaving much to be desired insofar as effective protection of the interests of consumers is concerned. Because of the limited and unsatisfactory nature of this form of international control, this Government may find reason to concern itself with the broad problems of creating a more acceptable form of international control of the production and marketing of minerals.

The Monetary and Economic Conference, meeting in London in 1933, adopted a resolution setting forth a number of principles to which international agreements relating to the coordination of production and marketing of commodities should conform. The following, 3 (d) of the resolution, lays down the agreed basis for the protection of the interests of consumers:

"It (the agreement) should be fair to all parties, both producers and consumers; it should be designed to secure and maintain a fair and remunerative price level; it should not aim at discriminating against a particular country, and it should as far as possible be worked with the willing cooperation of consuming interests in importing countries who are equally concerned with producers in the maintenance of regular supplies at fair and stable prices."

VII. Expansion of American Enterprise to Foreign Sources of Mineral Supply

The United States has led the world in the variety-abundance, and effective development of its mineral resources. A natural consequence has been the accumu lation of capital looking to investment in the mineral industries, the growth of a personnel highly skilled in exploration and development, and the projection of developmental efforts to foreign countries. Among the important minerals outside of the United States, in which American commercial interests share largely in control, are copper in Chile, Peru, Canada, and Rhodesia; vanadium in Peru; iron ore in Cuba, Chile, and Brazil; oil in Mexico, Venezuela, and other South American countries; oil in the Dutch East Indies; oil in Mesopotamia, in joint control with Great Britain, France, and the Netherlands through the Turkish Petroleum Co.; nickel in Canada; zinc in Canada, Newfoundland, Mexico, Peru, and Poland; asbestos in Canada; gypsum in Canada; manganese in Brazil; chromite in Cuba, Canada, and Brazil; bauxite in British and Dutch Guiana and in Europe. American enterprise and capital has shared with the British in the development of fully three-quarters of the world's minerals.

Since the war there has been a rapidly growing tendency the world over to restrict the mineral activities of our nationals abroad. Some countries have closed their borders, as well as those of their colonies and dependencies, entirely against such effort. Others have adopted restrictive measures which have greatly narrowed the opportunities for our activities. In some cases the movement has been accompanied by the adoption of retroactive measures which are more or less injurious in their effect on properties under foreign control. The "open door" for mineral exploration and development has been to a large extent closed. American capital still penetrates foreign fields, but American personnel is gradually disappearing from the management.

Some of these American mining enterprises abroad have served to develop mineral supplies most useful in supplementing the supplies available in this and other large industrial countries. In some instances the extension of activity at the time it was made seemed justified by indefinitely expanding American demand, e. g., in the fields of copper and oil. The relative decline in American demand has however made these enterprises dependent on markets outside of the United States rather than upon the American market. Furthermore, the marked trend in international commercial

relations along lines of a direct balancing of interchange between pairs of countries has created new embarrassments for them. Their fate has become increasingly dependent upon the development of American commercial relations and the American market.

In view of the different importance of each of the mineral fields to American national interest, and the infinite variety of political and economic circumstance entering into the policies of the countries in which they are located, it will always remain advisable that American action and policy in the matter be flexible and shaped in the light of each particular situation. However, it is suggested that wise American policy should in general observe the following directions:

(1) American influence should be exerted within the limits of equity and international law to sustain the acquired property rights of American mining enterprises abroad.

(2) The development of additional supplies from new low-priced foreign sources should in the long run serve the general interest. When such foreign supplies are competitive with domestically produced supplies a balance must be sought which takes into proper account (*a*) the situation of the domestic industry, and (*b*) the interest of the consumer.

(3) The effort of the American Government to secure equality of access to resources and equality of treatment in the development of those resources should be sustained.

(4) The development of foreign supplies of those minerals needed to supplement domestic supplies should receive more definite encouragement than the development of those minerals of which there is already domestic abundance.

(5) The enterprises located abroad should be encouraged to develop trustworthy and fair relationships with the government and people of the country in which they are located. Most of these enterprises have exerted themselves to this end and their usefulness to the foreign country in which they are located has been recognized.

VIII. Economic Sanctions and Boycotts

Post-war recognition of the great part played by mineral raw materials in industrial progress and in national defense, and realization of the great inequality of distribution of essential minerals among industrial nations, have led to many suggestions that control of mineral supplies by international agreement could be used to enforce the keeping of the peace and to shorten wars.

The committee has not had time to study this knotty problem but plans to discuss the question in its later report.

PART V
REPORT OF THE BOARD OF SURVEYS AND MAPS

BOARD OF SURVEYS AND MAPS OF THE FEDERAL GOVERNMENT, WASHINGTON, D. C.

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AIR CORPS, WAR DEPARTMENT
BUREAU OF AERONAUTICS, NAVY DEPARTMENT
AERONAUTICS BRANCH, DEPARTMENT OF COMMERCE
BUREAU OF FOREIGN AND DOMESTIC COMMERCE, DEPARTMENT OF COMMERCE
GEOGRAPHIC SECTION, DEPARTMENT OF STATE
DIVISION OF MAPS, LIBRARY OF CONGRESS
BUREAU OF LIGHTHOUSES, DEPARTMENT OF COMMERCE

OCTOBER 29, 1934.

MR. FREDERIC A. DELANO,
Chairman, Advisory Committee,
National Resources Board,
Washington, D. C.

MY DEAR MR. DELANO: With reference to your letter of October 18 to the chairman of the Board, and to your telegram of October 22 to Col. C. H. Birdseye:

The Board, at an executive meeting held on October 22, completed the preparation of its comprehensive plan and program to complete the topographic mapping of the United States. In accordance with your request, a copy of the plan, and the committee's report on which it is based, as approved by the Board on October 22 is enclosed.

The report recommends methods, scales, and type of reproduction, and presents estimates on time and cost of a program to complete the standard topographic mapping of the United States. Time and cost are based on the assumption that required funds will be made available with assured regularity.

A base map of the entire area of the United States is a national need. The mapping of any part of that area, however important that part may be, falls short of meeting this national need. Such a map is not only a necessity for the efficient execution of Federal projects but is of vital economic importance in many State, county, municipal, and private activities, thus affecting the prosperity of the whole body of our people. The urgent need for adequate maps for national defense purposes is recognized by all. For these reasons it is reasonable to consider the national mapping plan as 100 percent a Federal project and that the expense of the project be borne by the Federal Government.

Assuming that a division of cost is desired, the only other source of funds would be from States or other civic subdivisions. State cooperation at best is not as reliable as it should be because of unfavorable financial conditions arising at critical times whereby a State may be forced to withdraw from its cooperative agreement. Such cases have occurred in the past in connection with State cooperation with the United States Geological Survey resulting in embarrassment to the Survey's financial set-up and plans. If State cooperation is involved in the financing of the national mapping plan, such conditions may arise as those previously mentioned and would undoubtedly seriously affect the accomplishment of the project by a curtailment of funds, which in turn would slow up the work and would undoubtedly eventually increase the costs. State funds expended by the Geological Survey for cooperative topographic surveys total for the past 10 years not more than $3,820,000. It might be anticipated that State appropriations for cooperative surveys in the next 10 years would not exceed that amount, or approximately $4,000,000.

The Board, therefore, unanimously voted that the program be 100 percent Federal, and that it be financed from Federal funds, except that where State or civic subdivisions desire larger scale maps than are now included in the program, such agencies will bear the additional cost thereof.

The Federal Government now maintains in the United States Geological Survey and the United States Coast and Geodetic Survey basic mapping agencies entirely competent to carry out the Board's program. The Board recommends that funds necessary for control and equipment pertaining thereto in this program be made available to the United States Coast and Geodetic Survey, and that all other funds be made available for use by the United States Geological Survey.

The Board of Surveys and Maps or its executive committee will be pleased to confer with you at your convenience to discuss the mapping plan and the matters referred to in your letter and telegram.

Very truly yours,

F. B. WILBY,
Lt. Col., Corps of Engineers,
Chairman of the Board.

Two enclosures:
Copy of the plan.
Copy of the committee report.

THE NATIONAL MAPPING PLAN

1. Most of the land-planning and land-use agencies of the Federal Government, as well as many other Federal and State organizations whose activities are concerned with land, have asked the Board of Surveys and Maps to prepare a program for the completion at an early date of the mapping of the United States. The Board has made an exhaustive investigation and finds much evidence that the actual loss of money due to lack of adequate maps is greater than the estimated cost of completion of the standard map of the United States. Moreover, most of the land-use agencies have testified that the absence of adequate map data makes it almost impossible to carry out any plan of readjustment in land use until the areas affected are adequately mapped.

2. Of the 3,050,000 square miles contained in the continental United States, exclusive of Alaska, only about 810,000 square miles (26 percent) have been covered by adequate topographic maps, about 740,000 square miles (24 percent) were mapped over 40 years ago by methods and on scales inadequate for present-day needs, and about 1,500,000 square miles (50 percent of the entire area) remain entirely unmapped.

3. The Board has prepared a program which, if adopted and carried out, will provide for the completion in 10 years of the standard surveying and mapping of the United States, and in 2 years of all essential areas needed for immediate planning purposes by Federal agencies.

4. *Plan:(a)* The plan adopted by the Board of Surveys and Maps of the Federal Government at its executive meeting on October 22, 1934, is as follows:

(1) The compilation of planimetric base maps from aerial photographs taken on a scale of about 1: 20,000 of all of the unmapped or inadequately mapped agricultural lands in the Eastern and Southern States, where the boundaries of farms and fields are irregular in shape, and most fields are relatively small, and of other areas of extreme economic importance, estimated to cover in all about 300,000 square miles; the publication of preliminary sheets without contours on a scale of 1:24,000; and the preparation of contour maps as soon as practicable after the planimetric maps are available and the publication of the results in advance sheet form on the scale of 1:31,680 and in final form on a scale of 1:62,500.

(2) The compilation of planimetric base maps from aerial photographs taken on a scale of about 1:31,680 of all of the unmapped or inadequately mapped agricultural lands in States where individual farms and fields are relatively large and regular in shape, and of other areas of moderate economic importance, estimated to cover in all about 1,216,000 square miles; the publication of preliminary sheets without contours on the scale of 1:31,680; and the preparation of contour maps as soon as practicable after the planimetric maps are available and the publication of the results in advance sheet form on the scale of 1:48,000 (4,000 feet to the inch) and in final form on the scale of 1:62,500.

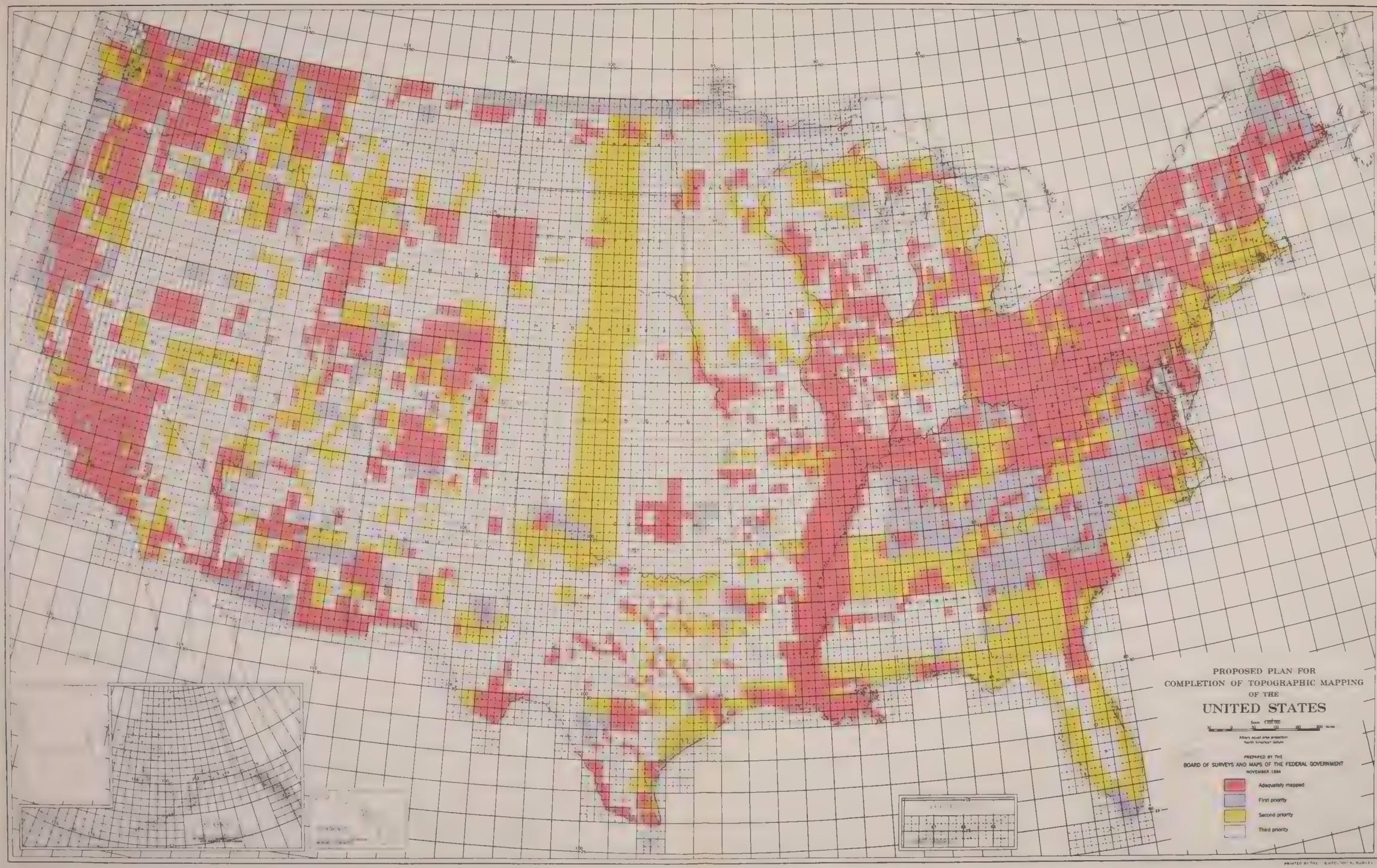
(3) The compilation of base sheets by adequate use of aerial photography of all other unmapped or inadequately mapped areas of minor economic importance, such as rugged mountains and sparsely settled deserts, estimated to cover about 700,000 square miles; no preliminary sheets without contours to be published but contours to be added as soon as practicable after the base sheets are prepared. The results to be published in advance sheet form on the scale of 1:96,000 (8,000 feet to the inch) and in final form on the scale of 1:125,000 (approximately 2 miles to the inch).

(*b*) The Board recommends showing on all preliminary sheets under (1) and (2) all fences and other property lines that can be identified on the photographs. Aerial photographs can be enlarged accurately to double scale and the base maps can be enlarged photographically to meet most of the needs of the various land use or land-planning agencies.

(*c*) The foregoing meets the requirements submitted by the various map-using agencies, with the exception of a few cases in which larger scales may be required In the event that any agency, or agencies, need planimetric or contour maps on larger scales, involving additional field and office work, funds in addition to those recommended below will be required.

5. *Priority of Areas:* (*a*) The Board tabulated graphically on a base map of the United States (see map facing page 76) the mapped areas of continental United States, exclusive of Alaska, showing thereon approximately 810,000 square miles covered by adequate maps, and approximately 739,300 square miles covered by inadequate maps needing resurveys, leaving about 1,476,600 square miles of unmapped territory.

(*b*) The Board also tabulated graphically on a similar base map (see accompanying map) the unmapped and inadequately mapped areas, and recommends dividing them into three tentative priority groups shown thereon (the first to be completed in 2 years, the second in the next 3 years, and the third in the last 5 years), with most of the inadequately mapped areas placed in the last group. These priorities are based


PROPOSED PLAN FOR
COMPLETION OF TOPOGRAPHIC MAPPING
OF THE
UNITED STATES
Albers equal area projection
North American datum
PREPARED BY THE
BOARD OF SURVEYS AND MAPS OF THE FEDERAL GOVERNMENT
NOVEMBER 1884
Adequately mapped
First priority
Second priority
Third priority

on present requirements submitted by the various map-using agencies, but they must be subject to modification to meet changing needs.

6. *Estimates for Aerial Photography:* The Board found the amount of aerial photographs available for adequate map work in unmapped or inadequately mapped areas to cover about 100,000 square miles. Additional aerial photographs will be required to cover about 2,000,000 square miles, at an average cost of $2.50 per square mile or a total of $5,340,000. It is doubtful that commercial aerial photographers will be willing to equip themselves with multiple-lens cameras suitable for a large part of the map work unless they can be assured in advance of work that will justify the expenditure. It is recommended, therefore, that the Federal air services cooperate in the aerial photography until civilian aerial photographers can meet the needs of the mapping agencies, or else that funds be made available to the Federal mapping agencies to purchase suitable mapping cameras to be furnished under bond to civilian photographers. Full use should be made of stereoscopic plotting instruments for making contour maps, especially in all areas which are not too heavily timbered and which are to be mapped with a contour interval of 20 feet or larger. The Board recommends that at least $200,000 be made available for the purchase of mapping cameras and stereoscopic plotting instruments, making a total of $5,540,000 for aerial photography.

7. *Estimates for Control Surveys:* The Board investigated the amount of horizontal and vertical control available and estimated the amount required to complete the mapping program. It recommends the completion of the 25-mile spacing of first and second order arcs of triangulation at an estimated cost of $3,500,000, and the extension of supplemental horisontal and vertical control surveys designed to provide the required number of additional points on each map sheet, at an estimated cost of $16,000,000. This, with an estimated requirement of $700,000 for instruments, trucks and towers, will completely control the area of Continental United States, exclusive of Alaska, for the purposes of this mapping program at a total cost of $20,200,000.

8. *Estimates of Mapping Costs:* The Board investigated the cost of each item in the planimetric and contour map program and submits the following estimates of average cost, exclusive of control surveys, aerial photography, and map reproduction, under each of the three classifications given above:

(1) Planimetric maps, 300,000 square miles, at $13 per square mile	$3, 900, 000
Contour maps, 300,000 square miles, at $57 per square mile	17, 100, 000
(2) Planimetric maps, 1,216,000 square miles, at $11 per square mile	$13, 376, 000
Contour maps, 1,216,000 square miles, at $27 per square mile	32, 832, 000
(3) Base maps, 700,000 square miles, at $6 per square mile	4, 200, 000
Contour maps, 700,000 square miles, at $15 per square mile	10, 500, 000

9. *Property Maps and Mosaics:* The Board feels that the making of ownership maps or mosaics, showing individual farms and other tracts of land with their acreage and the names of the owners, should not be a part of the primary mapping program but should be carried on by States, counties, or Federal agencies after the base maps have been prepared. The Board believes that these agencies could plot ownership data on individual aerial photographs, which offer the best means of acquiring the data, because the owner can see a picture of his farm and adjoining landowners can usually indicate to the surveyor an acceptable line between two farms. The acreage of each farm or field can then be scaled or measured with a planimeter and the data transferred to the base map or to a mosaic made from ratioed prints of the same photographs used in making the base map and in acquiring the ownership data. The legal reestablishment of property lines is a very expensive procedure and cannot be a part of the primary mapping program.

10. *Estimates for Map Reproduction:* (*a*) The Board investigated the methods and the cost of reproduction of adequate editions of maps prepared under the three classifications given above and recommends 4-color reproduction of planimetric sheets, 1-color reproduction of advance sheets of contour maps, and 5-color reproduction of final contour sheets, with all of the reproduction by photo-lithography, except possibly the most intricate final contour maps, which should be printed from plates made by copperplate or glass engraving.

(*b*) The estimates of cost for map reproduction are as follows:

(1) Planimetric maps, 300,000 square miles, at $2 per square mile	$600, 000
Advance contour sheets, 300,000 square miles, at $1 per square mile	300, 000
Final contour maps, 300,000 square miles, at $3.50 per square mile	1, 050, 000
(2) Planimetric maps, 1,216,000 square miles, at $1.50 per square mile	1, 824, 000
Advance contour sheets, 1,216,000 square miles, at $0.50 per square mile	608, 000
Final contour maps, 1,216,000 square miles, at $3.50 per square mile	4, 256, 000
(3) Advance contour sheets, 700,000 square miles, at $0.35 per square mile	245, 000
Final contour maps, 700,000 square miles, at $1 per square mile	700, 000

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11. *Total Estimated Cost:* (*a*) The total estimated cost of completion of the mapping of the United States according to the above schedule, including the resurvey of inadequately mapped areas, and the purchase of additional instruments and trucks, but excluding the making of property maps or mosaics, is tabulated as follows:

Control surveys	$20, 200, 000
Aerial photography	5, 540, 000
Planimetric mapping	21, 486, 000
Contour mapping	60, 722, 000
Reproduction	9, 583, 000
Total	117, 531, 000

(*b*) The total area to be mapped involves about 2,200,000 square miles, so that the average cost involves an expenditure of about $54 per square mile, or about 8 cents per acre.

12. *Program:* (*a*) In view of the urgent need of maps by all Federal planning and land use agencies at the present time the Board has provided a program which contemplates completing all of the mapping of areas requested by these agencies in 2 years. When the magnitude of the project and its wide dissemination in all parts of the country is considered, an orderly and efficient prosecution of the work will not permit reducing this estimate. The whole program is planned for completion in a period of 10 years, in which the horizontal control will be finished in 6 years, the planimetric mapping in 7 years, the vertical control in 8 years, and the final contouring in 10 years. The different elements of such a program should be coordinated so that they will proceed in a logical manner and contour mapping will proceed as soon as the planimetric base maps are prepared.

(*b*) The Board recommends that funds be made available in accordance with the following table, based on the detailed estimates shown in table I.

First year	$15, 000, 000	Seventh year	$10, 000, 000
Second year	15, 000, 000	Eighth year	8, 000, 000
Third year	15, 000, 000	Ninth year	7, 000, 000
Fourth year	15, 000, 000	Tenth year	5, 531, 000
Fifth year	15, 000, 000		
Sixth year	12, 000, 000	Total	117, 531, 000

13. *Federal Interest:* The board recommends that the program be 100 percent Federal, and that it be financed from Federal funds, except that where State or civic subdivisions desire larger scale maps than are now included in the program, such agencies will bear the additional cost thereof.

14. *Agencies Available to Carry Out Program:* The Federal Government now maintains in the United States Geological Survey and the United States Coast and Geodetic Survey basic mapping agencies entirely competent to carry out the Board's program. The Board recommends that funds necessary for control, and equipment pertaining thereto, in this program be made available to the United States Coast and Geodetic Survey, and that all other funds be made available for use by the United States Geological Survey.

TABLE I.—*Details of national mapping program*

Priority	Year	Item	Area (square miles)						Estimated cost						
			Horizontal control	Vertical control	Aerial photos	Plan maps	Contour maps	Reproduction	Horizontal control	Vertical control	Aerial photos	Plan maps	Contour maps	Reproduction	Total
First	1	Equipment							$500,000	$200,000	$200,000	$10,000	$290,000		$1,200,000
	1	First-order triangulation.							1,800,000						1,800,000
	1	(1)	116,000	116,000	116,000	116,000	58,000	58,000	696,000	145,000	348,000	1,708,000	3,306,000	$493,000	6,496,000
	1	(2)	186,000	126,000	186,000	114,000	62,000	62,000	1,116,000	157,500	465,000	1,254,000	1,674,000	419,000	5,085,500
	1	(3)	33,000	38,000	33,000	20,000	16,000	16,000	198,000	47,500	66,000	120,000	240,000	23,000	694,500
		Total	335,000	280,000	335,000	250,000	136,000	136,000	4,310,000	550,000	1,079,000	2,892,000	5,510,000	935,000	15,276,000
	2	First-order triangulation.							1,700,000						1,700,000
	2	(1)	50,000	50,000	50,000	50,000	58,000	58,000	300,000	62,500	150,000	650,000	3,306,000	361,000	4,829,500
	2	(2)	225,000	170,000	225,000	210,000	63,500	63,500	1,350,000	212,500	562,500	2,310,000	1,754,500	569,000	6,718,500
	2	(3)	60,000	60,000	60,000	40,000	16,300	16,300	360,000	75,000	120,000	240,000	244,500	30,300	1,069,800
		Total	335,000	280,000	335,000	300,000	137,800	137,800	3,710,000	350,000	832,500	3,200,000	5,265,000	960,300	14,317,800
		Total, first priority	670,000	560,000	670,000	550,000	273,800	273,800	8,020,000	900,000	1,911,500	6,092,000	10,775,000	1,895,300	29,593,800
Second	3	(1)	50,000	50,000	50,000	50,000	48,800	48,800	300,000	62,500	150,000	650,000	2,781,000	319,600	4,263,700
	3	(2)	300,000	180,000	250,000	260,000	122,700	122,700	1,800,000	225,000	625,000	2,860,000	3,312,900	880,800	9,703,700
	3	(3)	50,000	50,000	35,000	40,000	28,700	28,700	300,000	62,500	70,000	240,000	430,500	42,700	1,145,700
		Total	400,000	280,000	335,000	350,000	200,200	200,200	2,400,000	350,000	845,000	3,750,000	6,525,000	1,243,100	15,113,100
	4	(1)	50,000	50,000	50,000	50,000	48,700	48,700	300,000	62,500	150,000	650,000	2,775,900	319,150	4,257,550
	4	(2)	300,000	180,000	250,000	260,000	122,700	122,700	1,800,000	225,000	625,000	2,860,000	3,312,900	880,800	9,703,700
	4	(3)	50,000	50,000	35,000	40,000	28,700	28,700	300,000	62,500	70,000	240,000	430,500	42,700	1,145,700
		Total	400,000	280,000	335,000	350,000	200,100	200,100	2,400,000	350,000	845,000	3,750,000	6,519,300	1,242,650	15,106,950
	5	(1)	34,000	34,000	34,000	34,000	48,700	48,700	204,000	42,500	102,000	442,000	2,775,900	287,150	3,853,550
	5	(2)	200,000	180,000	250,000	260,000	122,700	122,700	1,200,000	225,000	625,000	2,860,000	3,312,900	880,800	9,103,700
	5	(3)	150,000	66,000	51,000	40,000	28,800	28,800	900,000	82,500	102,000	240,000	432,000	42,800	1,799,300
		Total	384,000	280,000	335,000	334,000	200,200	200,200	2,304,000	350,000	829,000	3,542,000	6,520,800	1,210,750	14,756,550
		Total, second priority	1,184,000	840,000	1,005,000	1,034,000	600,500	600,500	7,104,000	1,050,000	2,519,000	11,042,000	19,565,100	3,696,500	44,976,600
Third	6	(1)					20,000	20,000					1,140,000	90,000	1,230,000
	6	(2)	5,000	140,000	55,000	62,000	120,000	120,000	30,000	175,000	137,500	682,000	3,240,000	573,000	4,837,500
	6	(3)	357,000	140,000	270,000	238,000	125,000	125,000	2,142,000	175,000	540,000	1,428,000	1,875,000	208,300	6,368,300
		Total	362,000	280,000	325,000	300,000	265,000	325,000	2,172,000	350,000	677,500	2,110,000	6,255,000	871,300	12,435,800
	7	(1)					17,800	17,800					1,014,600	80,000	1,094,700
	7	(2)		140,000		50,000	150,000	150,000		175,000		550,000	4,050,000	675,000	5,450,000
	7	(3)		140,000	216,000	166,000	157,200	157,200		175,000	432,000	996,000	2,358,000	215,300	4,176,300
		Total		280,000	216,000	216,000	325,000	325,000		350,000	432,000	1,546,000	7,422,600	970,400	10,721,000
	8	(1)													
	8	(2)		100,000			150,000	150,000		125,000			4,050,000	600,000	4,775,000
	8	(3)		156,000		116,000	150,000	150,000		129,000		696,000	2,250,000	190,600	3,265,600
		Total		256,000		116,000	300,000	300,000		254,000		696,000	6,300,000	790,600	8,040,600
	9	(1)													
	9	(2)					160,000	160,000					4,320,000	640,000	4,960,000
	9	(3)					110,000	110,000					1,650,000	110,000	1,760,000
		Total					270,000	270,000					5,970,000	750,000	6,720,000
	10	(1)													
	10	(2)					142,400	142,400					3,844,800	569,600	4,414,400
	10	(3)					39,300	39,300					589,500	39,300	628,800
		Total					181,700	181,700					4,434,300	608,900	5,043,200
		Total, third priority	362,000	816,000	541,000	632,000	1,341,700	1,341,700	2,172,000	954,000	1,109,500	4,352,000	30,881,000	3,991,200	42,960,600
		Grand total	2,216,000	2,216,000	2,216,000	2,216,000	2,216,000	2,216,000	17,296,000	2,904,000	5,540,000	21,486,000	60,722,000	9,583,000	117,531,000

NOTE.—Reproduction items are included in same year as contour map items, but they may lag from 6 months to 1 year behind contour mapping.